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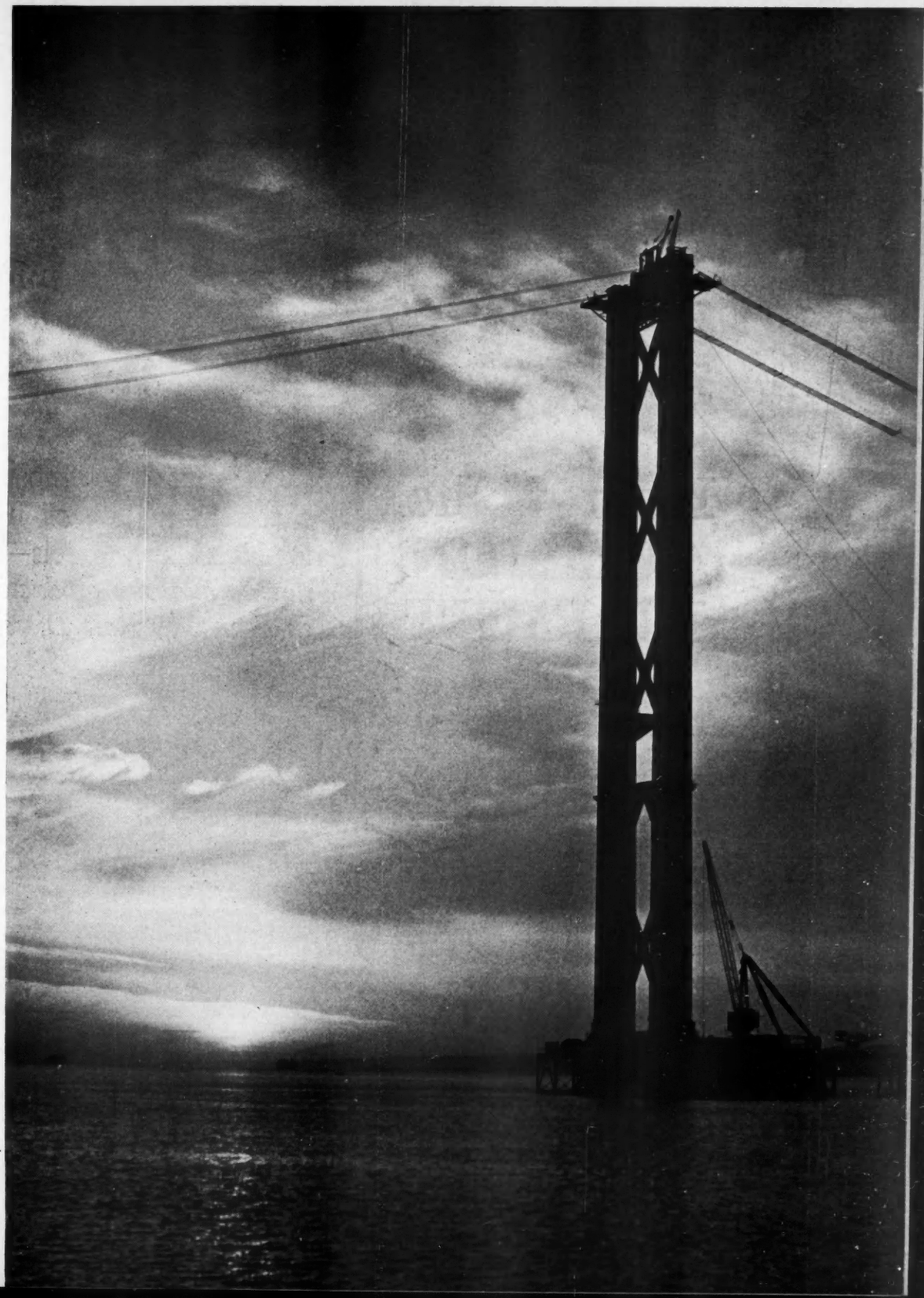

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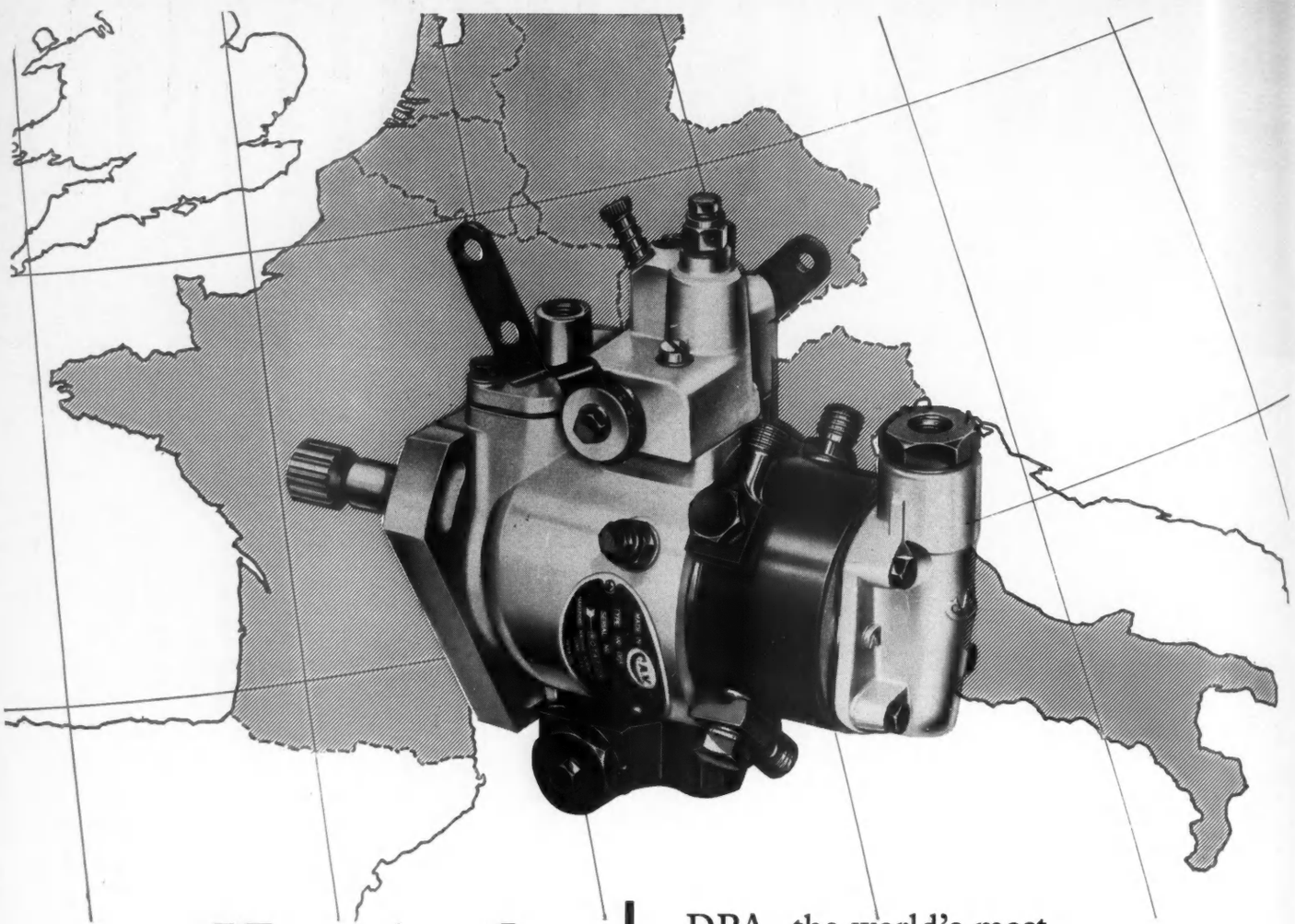

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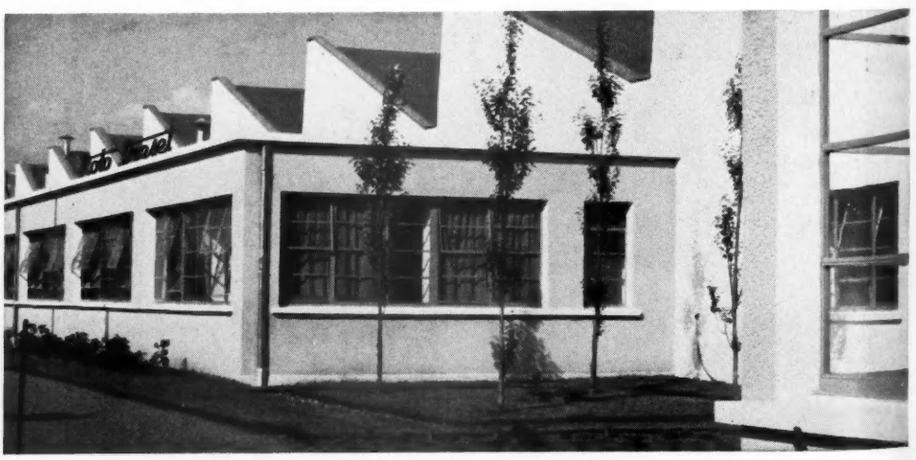

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Cover Picture

The northern tower of the Forth Road Bridge now under construction. It will be the longest suspension bridge in Europe. The two towers were completed earlier this year and the catwalks have been thrown across the river prior to spinning the main cables. The bridge is due to be completed in 1963.

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ENGINEERING Impact

of Labour's Concern for the Consumer

THE recently published pamphlet, "Fair Deal for the Shopper," is further evidence of the Labour Party's growing acceptance that the man-in-the-street (and, therefore, the voter) is a consumer as well as a producer. It paints a picture of the consumer as a defenceless creature whose life is complicated by unscrupulous manufacturers, machiavellian advertising agents and salesmen, a bewildering and widening choice of new materials, and inadequate government protection. It is suggested that the consumer's defence should be a Consumer Council.

One aspect of the council's work would be keeping a check on the £450 million per annum income advertising industry. Advertising, says the pamphlet, does not necessarily reduce prices but it does exploit emotions, fears and ignorance through the use of cleverly (often rather clumsily, one would have thought) contrived scientific terms. To offset this influence, says the pamphlet, the onus of proof of the truth of any advertisement should be on the advertiser and he should be open to challenge by the Consumer Council.

The pamphlet does acknowledge that there is such an animal as a reputable advertiser, and it looks favourably on the Advertising Association's own solution of giving their business a professional status with authority to expel members, if necessary, for unprofessional conduct.

Another subject tackled by the pamphlet is product quality. Often, it states, the consumer cannot know the true quality of goods, many of which are tagged with trade terms, such as "shrink-proof," "fadeless," "waterproof" and "greaseproof," which really mean anything or nothing. In Britain, the authors point out, there is only one quality symbol, the British Standards "Kitemark," and this is little used—in the case of some makers, because they make higher quality goods. The Consumer Council would therefore make arrangements for drawing up quality marks for higher grade goods.

Perhaps the establishing of quality grades is now made more practicable by the formation of the National Council for Quality and Reliability (ENGNG., 29 Sept., p. 406). Indeed, the formation of this council might even be the seed for the natural evolution of such a system of quality standards.

Even more important than new legislation, according to the pamphlet, is the administration and the enforcement of the laws protecting the consumer. The main function of the Consumer Council would be to see that these laws were used, and it would have the authority to initiate prosecutions. On other occasions, it is suggested, the Council's weapon might be adverse publicity and, for this reason, the right of the Council and of the Press and television to publish what is in effect damaging information to some businesses, but necessary for public protection, should be in turn protected.

The point at issue is whether there should be a Consumer Council with overall responsibilities or whether the question of consumer protection should be handled in a more fragmented way—by professional status in the case of the advertisers, by the National Council of Quality and Reliability in the case of product quality, and by the Consumers' Association and the Consumer Advisory Council for general objective publicity.

Electrical Equipment in Aircraft

ELECTRICAL engineers are challenged by Air Marshal Sir Herbert Spreckley: "On the perfection of the electrical and electronic systems will depend the future of the supersonic aircraft".

The occasion was the second annual dinner of the Electrical Engineers (ASEE) Exhibition. The Air Marshal went on to say that at the present time some 300-400 horse-power was being bled off from the engines for ancillary purposes, mainly electrical. When he started flying, 37 years ago, there was one 6-volt battery. The modern pilot was virtually a monitor of a closed system, and he had even been replaced in some of the later installations—in satellites for example.

He forecast that in ten to fifteen years' time supersonic flight would be usual in civil aviation, and with it would come at least short take-off craft if not those with vertical take-off. Both the rate of progress and safety depended on electrical engineers producing the perfect system which would provide automatic take-off and landing and include monitor circuits in operation the whole time.

This posed the problem of reliability as against weight and bulk, and the question of how many monitors would be required to monitor the monitors. Reliability was, therefore, the key word.

Some reliability figures were quoted by Air Marshal Spreckley. For every 1,000 hours flying in 1959, major failures of electrical apparatus were 0·01, and for hydraulic apparatus 0·08. However, for overall troubles, including all minor ones, there were 8·5 electrical as against 5·3 hydraulic failures. The present computer system for plotting navigational positions gave a guaranteed 150 hour's service life between failures. The design had been achieved by committee work, and it would be by committee work and cooperation that final reliability would be achieved.

The difficulty is international. All aircraft operators suffer from it, and therefore it is a great challenge to electrical engineers in Britain to take the lead by continued research and development.

Hovercraft Faith by Vickers

THREE weeks ago, ENGINEERING reported on the Vickers Group hovercraft programme which is being carried out by Vickers-Armstrongs (South Marston) Limited. The news that they have now set up a Hovercraft Division at South Marston indicates their faith in the future of this mode of transport. Is this faith justified?

With commendable reticence, Vickers have until now said little about their progress as one of the four companies working in conjunction with Hovercraft Development Limited. Mr. S. P. Woodley, general manager of the South Marston company, says they have now reached the stage where they know where they are going and during the next year he expects dramatic developments in hovercraft.

ENGINEERING recently observed the VA-1 research craft in action. Over the past twelve months it has undergone extensive trials over water and land. The information gained from this development tool is being fed into the VA-3, a 24 passenger craft which is under construction and which will be ready early next year. (VA-2 is a portable model for demonstration purposes throughout the world.)

Mr. Woodley also said that Vickers expect solid business from hovercraft in about five years, and as the engineering problems are solved he expects hovercraft to make a big impact on transport in the next five to ten years.

If commercial success is to be achieved, then hovercraft must be made available to potential operators in the near future. The company which can offer the most attractive craft first will have the best of the market. Vickers have a great tradition in building aircraft and ships. They appear to be all set to reap the fruits of this new concept in heavy transport.

Mr. Hennessey, of Hovercraft Development, believes there is little doubt that Britain will build the first commercial hovercraft of 100 tons or more. He has also said that we are ahead in development and intend to stay ahead.

The inventor of the hovercraft principle, Mr. C. S. Cockerell, contends that if this new concept "is to be fully exploited then I estimate that we ought to be spending an average of ten million pounds a year on development for the next twenty years." Mr. Cockerell is inevitably biassed, but Vickers have taken a cold, clear look at the prospects and found them rosy.

of Electricity's Peak Power

LAST year, 1960, saw an increase in the total consumption of electricity in England and Wales of 12 per cent. The greatest increase was in supplies to domestic consumers, which were up by 17·6 per cent. How to provide for this continued increase is the problem facing the Electricity Council and the Central Electricity Generating Board.

Initially the problem, like so many others, is one of finance. The Council will be seeking to raise the borrowing ceiling to £2,300 million, as they are entitled to do under present legislation. So far they have managed to raise some 45 per cent of expenditure from internal resources, but the expansion in capital equipment must go on. In 1960 the peak demand was 24,445 MW, reached on 13 December—and that day was not as cold as the "average cold spell" expected. With an absolute maximum output capacity of 27,067 MW (counting all plant as fully available) the margin seems rather small. The increase in demand rose 5·9 per cent in the year, and the increase in capacity by 6 per cent.

Planning is done annually for a seven year period. So far, all estimates of demand have had to be revised upwards each year. For example, the figure estimated in 1958 for the demand in 1960-61 was 23,540 MW; had the "average cold spell" conditions occurred it would actually have reached 25,000 MW, some 6 per cent higher. Similarly the demand for 1964-65, then estimated at 29,460 MW, has now been revised to 33,200 MW—an increase of 12 per cent.

One advantage of the construction of new stations is that the cost of installation and the cost of generation are both kept down, the former because of improvements in design and the latter by improvements in efficiency. The average efficiency of the 230 stations rose by 0·3 per cent to 26·8 per cent during the year, but some of the older stations which had to be used to meet the peak demands were still only just over 10 per cent efficient.

The three problems before the Council are: how to replace the inefficient stations; how to finance the new installations; and how to improve the distribution system.

Public Relations of the Engineering Institutions

MEMBERSHIP of the Institution of Mechanical Engineers now numbers almost 55,000. The Institution of Electrical Engineers have reached a total of nearly 48,000. Such large figures present serious problems to the institutions if they are to maintain effective communication with their members, with the public and with the Establishment.

The Electricals have taken an important step in this direction. Mr. W. K. Brasher, secretary of the institution, has appointed their first public relations officer, Mr. P. D. G. Heneker, who for the previous two years had been his personal assistant. The official announcement of this appointment speaks of the intention to "ensure that the lines of communication, both outwards and inwards, between the Council of the institution and both the technological and the lay public, are used to their best advantage by means of a more positive public relations policy than has hitherto existed."

The Mechanicals do not employ a full-time public relations officer, but they are holding two Open Days which should strengthen the informal links between members and the secretariat at headquarters. Building alterations and extensions which have recently been completed were open to inspection by the members last week, and will be again on 8 November.

Institution links with the outside world are not self-evident, but they exist, particularly in the form of representation on numerous Government and other committees. At the highest scientific level, the Royal Society sometimes act as the coordinating agent of the engineering institutions. For example, at the recent London conference of the International Council of Scientific Unions, the Royal Society was the UK national member, as well as host. Though most of the science interests of the ICSU are non-engineering, there are certain fields which are of engineering significance, such as space research. In these fields the engineering institutions are represented by virtue of their representation on Royal Society committees.

Evaluating the Rotary Screw Compressor

By John Munck,
Atlas Copco AB, Stockholm

The rotary screw compressor is making rapid progress as a radically different method of compressing air. This article evaluates the design in relation to other members of the compressor family.

WE ARE seeing today the rapid progress of a radically different method of compressing air, i.e., by the rotary screw compressor. This article is an attempt at objective evaluation of this new design in relation to the other members of the compressor family, the piston and vane types of machine. For the sake of clarity, only stationary compressors above 150 cfm are considered.

Fundamental Principles

The most common compressors can be divided into two groups—displacement and dynamic. In the displacement compressor the air is sucked into the compression chamber, the chamber is separated from the suction side, and the chamber volume is diminished. When a certain pressure is reached, the discharge opens and during the continued decrease of chamber volume the air is moved to the delivery pipe.

The air flow through a displacement compressor is completely guided, so that the capacity is proportional to the shaft speed. Another characteristic feature is that the discharge volume rate of flow measured as free air delivery —i.e., air of intake condition—is practically unaffected by the working pressure provided this varies within reasonable limits.

Fans and turbo compressors belong to the dynamic category. The air is accelerated in a high-speed impeller and thereafter this kinetic energy is converted to pressure in diffusers. Thus the capacity and working pressure are chiefly determined by the shaft speed. The attainable pressure is also proportional to the specific gravity of the gas being compressed. Dynamic compressors are thus not suitable for use as vacuum pumps. For compression of a light gas such as hydrogen many stages are needed. If in a certain dynamic compressor one stage is needed for the compression of air to a given pressure, then 15 stages are needed to compress hydrogen to the same pressure provided that the peripheral velocity is kept constant.

Piston Compressors

The piston compressor, the most common displacement unit, has always been built for widely varying capacities and pressure ratios. In a conventional piston compressor the rotating motion of the drive shaft is transmitted via a crank mechanism and converted to the reciprocating motion of a piston in a cylinder. During its travel from top to bottom the piston breathes atmospheric air into the cylinder. On the return stroke the air is compressed and pushed out of the cylinder into the delivery pipe. To make the air flow only one way, in the desired direction, the compressor is fitted with intake and discharge valves usually self-acting.

In the compressor of today, where the reciprocating parts have been lightened considerably thanks to new materials and high shaft speeds and where the balancing of the parts has been greatly improved, the unbalanced forces no longer constitute a problem. Foundation and installation costs are generally not higher than for other classes of compressor.

The high shaft speeds have been made possible through the development of self-acting valves. Present day valves are able to operate at high speeds while maintaining high efficiency and long life. This means that the piston compressor can be directly connected to its electric motor.

The field for piston compressors has been from the smallest paint-spray units up to 5,000 cfm, sometimes bigger, and from 15 lb per sq. in to about 140,000 lb per sq. in. For extremely high pressures it has been the only choice. The piston compressor is characterized by high efficiency especially above 40 lb per sq. in.

Compression to higher pressures is carried out in several stages, with recooling of the air between each stage. The efficiency is hereby greatly increased and the temperature rise of the air kept low.

The benefit of multi-stage compression, of course, applies to all kinds of compressor. By the use of carbon or Teflon piston rings, which do not need lubrication, or by the use of labyrinth type pistons, piston compressors are built that deliver oil-free air—a prime need in the food and chemical industries.

Vane Type Compressors

Another common displacement unit is the vane compressor. In the cylindrical housing an eccentrically guided rotor revolves. This rotor has radial grooves in which the vanes are fitted. The volume trapped between two vanes and the surfaces of the housing and the rotor undergoes cyclical changes as the rotor revolves. When the volume increases it communicates with the intake through openings in the housing. When the second vane has passed the intake port opening, the volume decrease begins. The compression continues until the first vane uncovers the discharge port in the housing wall.

The frictional losses can be diminished by the use of two loosely rotating peripheral rings which carry the centrifugal force from the vanes. Their diameter is slightly smaller than the inside diameter of the housing. Part of the gain is lost owing to the necessity of providing clearance between the vane tips and the housing.

The vane compressor is well balanced and is suitable for direct drive from medium high-speed motors. The usual field of application is 150-3,000 cfm at 7-150 lb per sq. in. It is mostly used in the lower pressure ratios. The efficiency of the vane compressor cannot compete with that of a piston compressor. Drawbacks are also the decline in efficiency due to wear and the high oil consumption.

The Root's Blower

The third displacement unit that has found wide acceptance is the Root's blower. Its main parts are its two intermeshing similar rotors synchronized through outer timing gears and rotating bearings built into the plane end walls. The housing has two cylindrical inner surfaces against which the rotor tips seal. Rotors are made with two or three lobes which can be straight or helical. The air enters and leaves radially.

During rotation a volume is sealed from the intake by the lobes and the housing, whereafter it is transferred to the discharge side. When the rotor tips uncover the discharge opening, air from the pressure side enters the separated volume and fills it up. This machine thus works against full back pressure without continuous compression. This makes for a high power consumption, especially as pressure goes up.

The field of application is from 100 to 10,000 cfm and from 1 to 14 psig as a single-stage unit. As a single-stage vacuum pump it can maintain a 50 per cent vacuum.

From the viewpoint of service and wear the Root's blower is very good. Thanks to the outside synchronizing gear the rotors need no lubrication. The machine therefore delivers oil-free air. Owing to the pulsating compression it is, however, noisy.

Turbo Compressors

Among the dynamic, or turbo, compressors one distinguishes between the radial and axial flow types. They are similar to multi-wheel fans. The first turbo compressors were manufactured at the beginning of this century and were of the radial (centrifugal) flow type.

The air or gas enters the first wheel axially, is turned and leaves the wheel radially. Between stages are fixed guide vanes which direct the gas flow to the next stage. The gas velocity is lowered in passing the guide vanes and the dynamic pressure is converted to static. For a given gas the pressure ratio across each stage is determined by the wheel design and the tip speed. In the early models, the gas was cooled by having the internal walls of the compressor water-cooled.

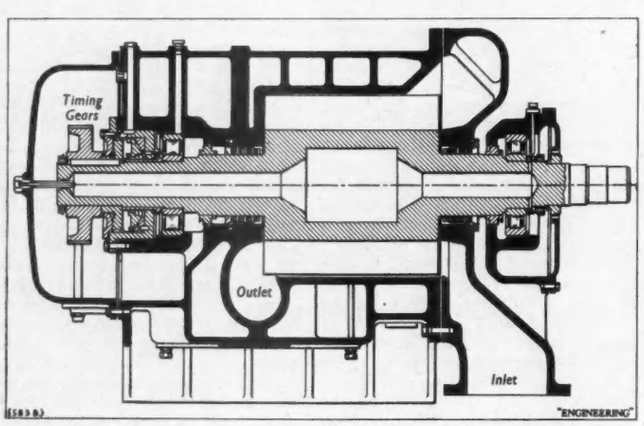


Fig. 1 (left) Longitudinal section through a rotary screw compressor. The casing is watercooled and the rotors oil cooled. The drive is on the male rotor.

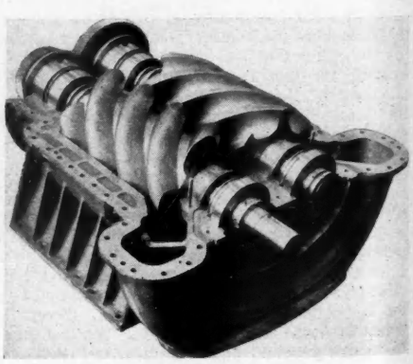


Fig. 2 (right) Rotary screw compressor viewed from the inlet end with top casing removed. To the left are the timing gears.

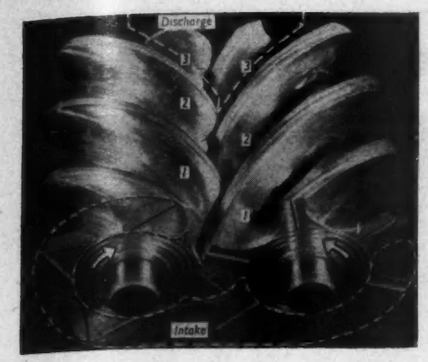


Fig. 3 Working principle of the rotary screw compressor. Male rotor on the left and female rotor on the right.

Nowadays there are separate intercoolers to which the gas is piped after every second or third stage and then fed back to the next stage group. This method makes for a simpler and lighter design together with a higher efficiency.

Such an interstage cooler is easier to employ for a radial flow unit than for an axial flow unit. For small volume rates of flow and high pressures the radial flow compressor is used exclusively and for very high volume flows only axial type compressors are used. In between is a common field. The volume rate of flow from a turbo compressor cannot be controlled by changing the shaft speed as this also affects the discharge pressure.

Assuming 100 lb. per sq. in working pressure the field of applicant can be said to fall between 35,000 cfm and 250,000 cfm. For special applications such as wind tunnels axial flow compressors have been built which can handle 13 million cfm. Turbo compressors are normally used from 2 to 150 lb per sq. in. The air is oil-free provided the bearings are suitably designed.

For low working pressures good efficiency can be obtained for small flow rates, but to maintain it the capacity must be increased as pressures go up. Turbo compressors can fully utilize high speed prime movers such as steam and gas turbines.

Rotary Screw Compressors

The newcomer, the rotary screw (Figs. 1 and 2), is a displacement compressor and at first sight it resembles the Root's blowers. It differs from them, however, in that it has internal compression. It can be compared to a piston compressor with mechanically operated valves.

The compressor has two rotors, the male having convex threads, and the female concave flutes. The drive is usually on the male rotor. The female rotor is driven by a synchronizing gear. The rotors revolve in a housing, the inner surface of which consists of two circular cylinders. The ends of the housing have ports for inlet and outlet, which usually extend a little over the length of the rotor. The compression cycle can be followed in Fig. 3. The flute 1, intermeshing with thread 1, has been filled with atmospheric air and the inlet has been closed. In position 2 the trapped volume decreases as the rotors turn and the pressure increases. In position 3 the discharge port is uncovered and delivery commences.

A forerunner to the rotary screw compressor is Krigar's blower patented in Germany in 1878. This had rotors with two threads and no internal compression. It was used for a pressure of 20-40 in wg so the absence of internal compression did not matter much. At the beginning of the thirties the rotary screw compressor was developed by Professor Alf Lysholm of the Royal Institute of Technology in Stockholm, Sweden. He was then working with AB Ljungströms Ångturbin, now Svenska Rotor Maskiner AB.

Lysholm was working on an aircraft gas turbine engine and was looking for a surge-free compressor. To obtain internal compression it was found that a convex thread must intermesh with a concave flute and that a minimum of three threads were required. The first test unit had three threads on both rotors.

In a section perpendicular to the rotor shaft the profile consisted of a circular arc on one flank, and a generated curve on the other. This gave good sealing between the rotors but also a long sealing edge, and there were manufacturing difficulties. Nowadays the rotor profile consists mainly of a circular arc and only a short section is generated. See Fig. 4. This new profile gives a shorter sealing length, and manufacture is simplified and can be carried out with great accuracy. As a result there is higher efficiency and greater mechanical safety. Three threads on both rotors gives a low flexural resistance so the combination of 4 on the male and 6 on the female is normally used. Then, both rotors have about the same flexural rigidity. Other possible combinations are 3 + 4, 4 + 5, 5 + 7, and 6 + 8. For low pressure ratios the comtination 3 + 3 has the benefit of maximum capacity for a given size and speed.

Between the rotors, as well as between the rotors and the housing, a certain clearance exists. There is no metal to metal contact that can cause wear so there is no need for lubrication inside the compressor. The delivered air is therefore completely oil-free. The clearance between the rotors is maintained by gears mounted on one end of the shafts. These synchronizing gears transmit practically no torque as the driven rotor, the male, absorbs nearly all the power.

The losses in a rotary screw compressor are eakage and dynamic and mechanical losses. The volumetric efficiency is a measure of the leakage losses. It is defined as actual free air delivery divided by displacement, see Fig. 3. The intermeshing flutes 1 on the two rotors define a volume which is outwardly bounded by the inner wall of the housing. There are four such volumes for each turn of the male rotor. Multiplication with the shaft speed yields the displacement per unit of time.

As the leakage flow is practically constant it will proportionately decrease with increased shaft speed, whereas the dynamic and mechanical losses increase. Where the sum of the three losses has its minimum is the optimum shaft speed from the viewpoint of efficiency.

To keep the leakage losses small, clearances must be small—how small being determined by manufacturing accuracy and mechanical security. The profile used by Atlas Copco has been developed with this fact in mind. From a mechanical point of view the shape is favourable, as any contact between the rotors is a rolling contact and any contact between the rotors and the casing occurs between an edge and a surface. The rotor tips and ends have small protruding sealing edges that can rub without generating much heat. The dynamic losses are kept low by careful shaping of the ports.

The shape of the outlet ports is determined by the pressure ratio for which the compressor is designed. This built-in pressure ratio is a constant for each compressor. It is chosen as close to the actual operating conditions as possible. In spite of this the pressure adjusts itself to correspond to the pressure prevailing in the discharge pipe. As the efficiency curve is remarkably flat, quite substantial deviations from the built-in ratio can be tolerated without sacrificing too much efficiency. See Fig. 5. The total efficiency has thus a maximum for a certain shaft speed and a certain pressure ratio.

If the discharge pressure does not coincide with the built-in pressure ratio a pulsating pressure equalization sets in every time the outlet port is uncovered by the rotor. In comparison with the Roots blower these pulsations are naturally much smaller. These pulsations, however, make themselves known in the form of sound. As the rotary screw compressor has a high shaft speed and more threads this sound will be high-pitched and therefore easier to dampen with a muffler in the discharge. The rotating masses of the rotating screw compressor are fully balanced and the only parts subject to wear are the bearings and the synchronizing gears. If these items are amply dimensioned a long life for the machine can be ensured.

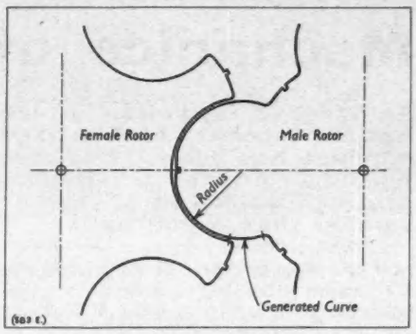


Fig. 4 Present rotor profile.

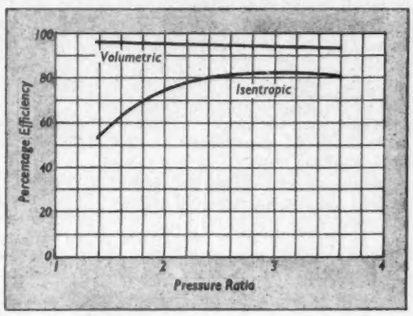


Fig. 5 Volumetric and isentropic efficiency versus pressure ratio. Built-in pressure ratio of this compressor is 2·8.

The best suited field of operation is from 600-21,000 cfm and from 5-150 lb per sq. in. Higher pressures can, however, be reached. A specially favourable field is between 5,000-21,000 cfm when direct drive from two-pole motors is possible. As with the turbo compressors, the lower limit is set by the shaft speed, which must be increased to keep the leakage losses acceptable. The tip speed should be roughly constant. For 700 cfm a shaft speed of 15,000 rpm is required. The upper limit is determined by the manufacturing facilities, expecially those for cutting the rotors. At low pressures the compressor is not competitive. The upper pressure limit is set by the forces from the air pressure which affect the bearing loads and cause deformation of the rotors.

At lower capacities the efficiency falls below that of piston compressors. For higher capacities the efficiency falls below that of piston compressors. For higher capacities the efficiencies are comparable to those of piston and turbo compressors. The rotary screw compressor can also be used as a vacuum pump. A two-stage standard compressor can maintain a vacuum of 96 per cent. Higher vacua are possible by special methods. The rotary screw compressor can also be operated as a motor.

Summary

For stationary air compressors the most common working pressure is 100 lb per sq. in. At this pressure the piston compressor has a strong foothold in competition with other types up to 3,000-4,500 cfm or, expressed in input, 600-1,000 hp. For very big units about say 20,000 cfm (4,000 hp), the turbo compressors have been most popular. The newcomer, the rotary screw compressor, spans the gap between these two and is also competing with the piston compressor at the lower end of the scale and with the turbo compressor at the higher. Further, the rotary screw compressor can also compete below 3,000 cfm where its technical merits, such as freedom from oil, perfect balancing and long overhaul periods are important.

Mechanics of a New Kind of Typewriter

An electric typewriter which has no typebars and a fixed carriage has been introduced by IBM. All the characters are contained on a sphere smaller than a golf ball.

A NEW electric typewriter just introduced, known as the IBM 72, presents an entirely new concept in typing. Instead of a moving carriage and 44 typebars, it has a hollow spherical typing head smaller than a golf ball which contains all the 88 characters.

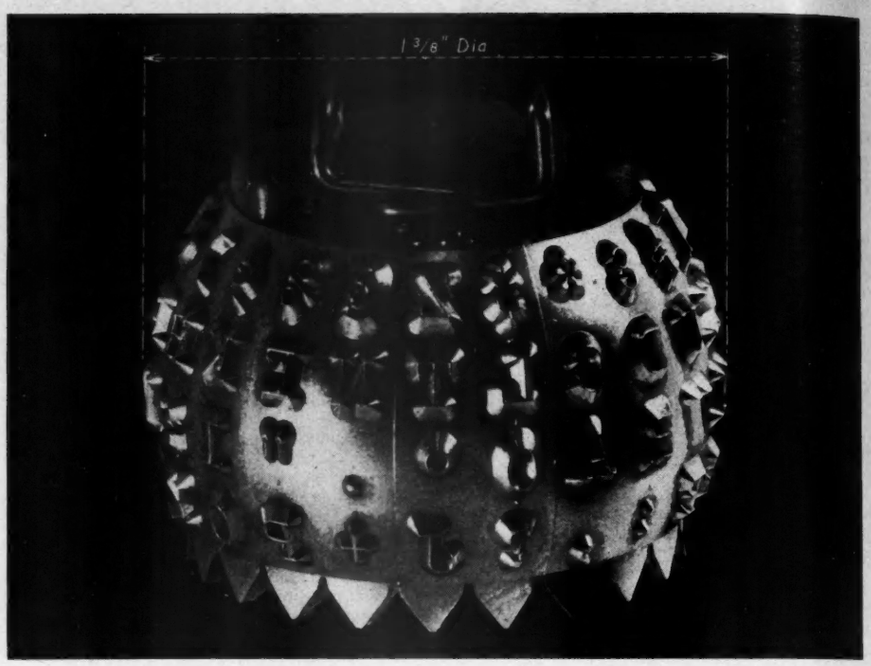
This type head, which actually measures 1⅜ in diameter, is mounted on a head and rocker assembly which in turn is mounted on a small carrier. This carrier glides along a cylindrical rod from left to right while typing. The 88 characters on the type head are arranged in four rows with 44 characters in each half of the sphere—four rows of 11 characters.

When a key is pressed it selects a number of latches to give the required output. This output is passed to a rotate arm which is connected by tapes to the type head. According to the position of the required character on the type head so the rotate arm pays out or pulls in the tape, thus correctly rotating the type head. Simultaneously another tape tilts the type head—through bevel gears—to bring the particular character in the vertically selected row normal to the ribbon. The type head is then rocked against the ribbon and paper to print the character.

The type head has two axes of rotation, one through the poles and the other through the equator. The twin motions about these axes occur simultaneously as the selected character is moving forward to print. When the type head is at rest, it is in its " home " position, which is at its upper row and in the centre of the 11 characters. As the selection occurs, the sphere rotates a maximum of 82° about its axis and approximately 50° about the equator, prints and returns home.

When the shift key is operated, the sphere rotates 180° and assumes a new " home " position, centred in the upper row of the 44 characters. Only 0·06 sec elapse from the time a key is touched to the time the character is printed; this gives the machine a usable speed of over 180 words per min.

The type head on which the 88 characters are mounted is made of nickel-plated urea-formaldehyde plastic. It weighs about the same as one conventional type bar. It has been said by IBM that the development costs for the type head were approximately £5,000. To give a perfectly even line of typing, each of the characters was specially designed and then positioned on the head to an accuracy of something like 0·001 in.



The type head measures only 1⅜ in diameter and yet contains all the 88 characters. When a key is depressed it simultaneously tilts, rotates and is then rocked against the ribbon and paper for printing.

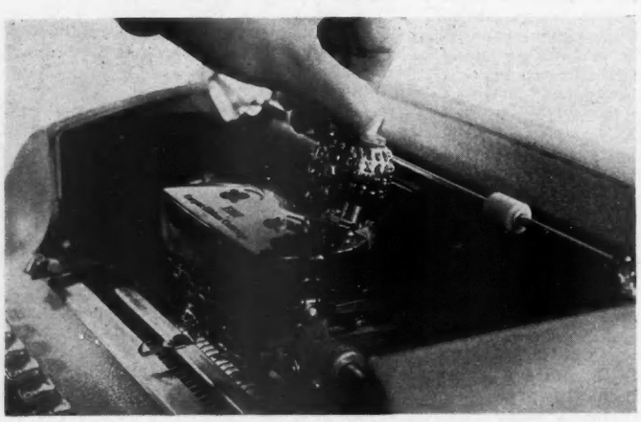
A stroke storage system enables a character to be stored while another is being typed. The purpose of this is to overcome the problem when a typist strikes two successive letters so fast that on an ordinary typewriter the second letter will either not print or the type bars will jam. On this machine there are of course no type bars to jam, but to ensure the second letter is printed the stroke storage system will store it for a fraction of a second, until the type head is correctly positioned and then print the second letter. It is designed to accept two characters separated by as little as 20 milli-seconds, which is far faster than a human can type at a maintained speed. (A fast typist will type at a rate of 10 characters per second and an average typist at 6 per second.

Because the type head is the element which does all the moving and not the paper carrying unit, the need of a conventional typewriter carriage is eliminated. The carrier weighs only 1 lb compared with 8 or 9 lb for a conventional carriage. This low weight of the moving elements permits fast movement of the carrier when tabulating and returning it to the left hand margin without disturbing the stability of the machine. One practical advantage from the typist's point of view is that since there is no carriage, no space need be allowed on either side of the machine during typing.

The type head is easily and quickly removed by depressing a spring clip. This allows for a change of type face or mathematical symbols and each type head costs £5. Ribbon changing is also simple, for a clip-on cartridge is mounted on the typing carrier and the ribbon itself does not need to be touched. It is possible to use several colours on one page by changing the cartridge.

The keyboard has been ergonomically designed and is contoured—based on wrist radius—to make every key more accessible to the typist's fingers. The keys themselves are more hollowed out than usual. Cost is comparable to IBM's standard electric typewriter.

IBM United Kingdom Limited, 101 Wigmore Street, London W1.



It is an easy matter to change the type head. The ribbon cartridge is on the same carrier.

The IBM 72 with cover removed. It weighs only 30 lb against 45 lb for the standard electric model.

More News of Vickers' Hovercraft

Reference to the article published in these columns three weeks ago (ENGNG., 15 Sept. '61, pp 330/1) about the Vickers-Armstrongs hovercraft activities will give the details of the craft built, building or projected.

Since then, ENGINEERING has visited the South Marston works and seen something of the research work done on hovercraft and also the VA-3 hovercraft in production.

For some time it has been known that recirculation of the air flowing out of the sides of the cushion would bring increased efficiency in lift, save lift-power and reduce spray. Unfortunately, the ingress of dust, debris and water which comes with the re-circulated air is such that the lift fans suffer considerable damage. Vickers felt the only way to study these problems was to build a simple craft on which a variety of duct and nozzle configurations could be studied.

The outcome is the VA-1 which over the past 12 months has undergone extensive trials. Its rectangular plan form is regarded by Vickers as the most advantageous for commercial purposes although it has posed problems at low speeds. This is due to the bow of the craft being struck by the oncoming air as the craft moves along. A long narrow craft would oscillate more violently than a short wide one and it would appear that the aspect ratio is fairly critical.

The recirculation method has for the time being been dropped by Vickers in favour of the annular jet. This is not because they think there is no future in recirculation but they feel that it is more important to press on and produce commercial hovercraft now, and come back to the problem later.

The VA-1 has a spray reducing deflector fitted along each side as can be seen from the photograph. Tests have been carried out in a spray rig at South Marston to try and reduce the considerable embarrassment of excessive spray due to the force of the air jets striking the water. Vickers have now devised a double vane deflector which, because the air enters through it, breaks down the vortices in the water. In addition to reducing spray the deflector increases the cushion pressure by about 10 per cent. The cushion pressure on which Vickers are at present working is from 18 to 20 lb per sq ft.

Wind tunnel tests on the VA-3 include smoke jets flowing over the craft to show how the air is taken into the fans and how the air intakes function. The action of the air as the craft moves through it, and the interaction of this air to the air cushion can also be studied.

The action of the spoilers can be studied in the stability rig. The spoilers, which are situated in the ducts, reduce the cushion pressure on any one side of the craft. This gives some measure of directional control. How much, can be seen from the rig where a section of duct is reproduced with a spoiler in each side, and the decrease in cushion pressure brought about by closing the spoiler on one side causes the gap between the moving floor and the duct to be reduced. Differences in load on the rig were from 55 to 40 lb measured on a spring balance to which the moving floor was attached.

The VA-1 research hovercraft. Spray has successfully been reduced by fitting deflectors, which can be seen along the side.

The cruising speed for the VA-3 is 60 knots and at such speeds Vickers do not expect any trouble with ram pressure building up in front of the craft and sweeping away the curtain of air underneath.

The various shapes and forms of hovercraft now appearing indicate that there is much work to be done in finding the optimum basic design configurations. The VA-3 now building closely follows aircraft practice in the weight-conscious attitude shown and also in the methods of construction.

Vickers-Armstrongs (South Marston) Limited, South Marston, Wilts.

Winch Allows Wire to Work Near its Yield Point

A new type of electro-hydraulic deep-sea oceanographic winch has been exported to Canada by the Telegraph Construction and Maintenance Company Limited (Telcon) a member of the BICC group. It was specially designed to the requirements of the Department of Mines and Technical Surveys of Canada for installation in one of their vessels.

The barrel of the winch accommodates 30,000 ft of $\frac{3}{16}$ in dia wire and when working at its extreme limit with the scientific apparatus attached, the wire must work very near its yield point.

Accordingly, a tensioning control device is incorporated to over-ride the effect of varying amounts of wire on the drum. Safeguards have also been incorporated in the design to ensure smooth operation throughout and to avoid snatching and jerking, which might put too great a load on the wire. Control of the winch is by a hand lever.

The automatic spooling gear, which can be mechanically or manually operated, has a cone clutch in its drive enabling final adjustments to be made by the operator. The barrel can be driven in either direction at a mean speed of 500 ft per min and the barrel may be made free-running for a gravity drop or for wire changing.

Tests were made on the winch to simulate as closely as possible actual working conditions, and installation on board was simplified by unit construction methods. Winch and controller were produced as an integral unit, as also were the power pack, reservoir and oil cooler.

These methods applied to all the pipe work, by-pass valves, shut-off valves and gauges, which were installed in a steel tray for fixing between the winch and the power pack. Thus by simply coupling the pipes to the equipment, filling with oil and connecting to the electrical supply, the winch was ready for operation. This method of construction also facilitates the transference of the equipment from one vessel to another.

British Insulated Callender's Cables Limited, 21 Bloomsbury Street, London WC1.

Large Screen Colour Projection Television System

A Swiss system of projection in colour television, known as "Eidophor", was recently demonstrated in London. It is a large screen system, and the term Eidophor (from the Greek word meaning image bearer) is basically applied to the projector, the television cameras being standard.

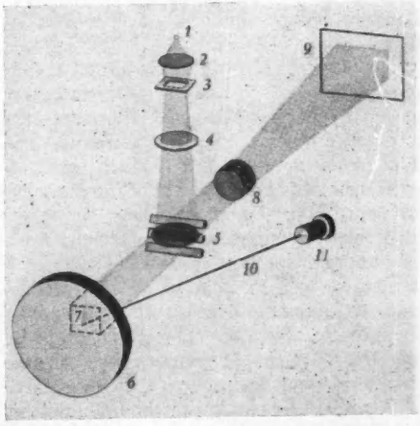
With this system, the electronic bombardment of a thin layer of oil spread over a concave mirror deflects from its path the light issuing from a powerful light source. This deflected light passes through the slits of a bar system and towards a projecting lens, which reconstitutes the televized image on the screen.

At the cathode ray tube (11 on drawing), video signals from the television transmitter or images from the camera modulate the electron beam (10) originating from the electron gun. The electrons strike the surface of the Eidophor oil film (7) which they deform by subjecting it to electric charges of varying intensity. These linear distortions cause the light coming from an independent source, a xenon arc lamp (1), to be deflected between the bar system (5) and, having passed through the projecting lens (8), to reproduce the televized image on the screen.

The Eidophor projector is suitable for transmissions both in monochrome and in colour. The size of the screen, which is 16 by 12 ft for colour transmissions, is increased to 30 by 22½ ft for black and white images. By using two synchronously rotating colour filter wheels over the camera lens and in front of the source of light, a colour picture transmission can be achieved on the principle of additive colorimetry.

At present the Eidophor system is not suitable for domestic receivers. It can be used for projecting monochrome pictures from a normal public television broadcasting system, but for colour projection it can only be used on its own closed circuit system.

CIBA Group of Companies in Great Britain Limited, 96 Piccadilly, London W1.



The "Eidophor" projection television system.

(1) Light source (xenon lamp)
(2) Condenser lens
(3) Picture window
(4) Lens
(5) Mirror bar system
(6) Concave mirror
(7) Oil layer (Eidophor or image bearer)
(8) Projecting lens
(9) Screen
(10) Electron or cathode beam
(11) Cathode ray tube

Plain Words

By Capricorn

LET us now praise the demolishers. Let us laud the destroyers, the scrappers, and all those who dispose of the unwanted, cast-off clobber of our affluent society.

I have been reading *Battleship Wharf*, a book which is believed to be the first on shipbreaking to be published in Britain. It is the history of Hughes Bolckow Limited (of the Metal Industries group), who last week celebrated the 50th anniversary of their establishment at Blyth on the North East Coast. Horace White, the author, tells me he has written the book primarily for the employees of the company.

How right he is to state this as his main object, because although I am sure the book will find its way into many technical and general libraries, it is the men—and women—of this remarkable firm who deserve to be honoured. Shipbreaking is a tough and hazardous job, not only for those who do the physical work, but also for those who manage the business. The conditions can and do change unexpectedly—the price the shipbreaker can get for his scrap metals, the rate at which ships come up for scrapping, the time taken to break a ship up, and the availability of workers who are robust yet skilful, and not afraid of getting their hands dirty—very dirty indeed!

Horace White remarks "some of the steel recovered from the liner Mauretania when she was broken up in 1935 found its way, via the charging boxes of a Scottish steelworks, into the plates of the Queen Mary which was to succeed her as holder of the Atlantic blue riband." When I think of the vast scale of production of the industrial nations of the world today, I wonder why we don't devote more attention—even more scientific research—to the art and science of scrapping. Whereas scientists and engineers provide the impetus behind new developments for manufacture, the decision to scrap is largely a by-product of the accountant's balance sheet. It seems to me that there is great scope for someone to develop a new technology—the technology of scrapping. It could become a new instrument of policy. It might even be dubbed the fifth primary technology.

The United Kingdom Government are moving gingerly towards more extensive national economic planning. It bristles with political problems. My proposition is that a government might find it much easier to exercise a measure of control of the economy by controlling scrapping policy. It would be a relatively simple extension of the work of factory inspectors for them to direct a firm to scrap a machine which had become outdated because it was using manpower inefficiently. Such direction would stimulate the improvement of productivity, jolt the backward firms, and present the Government with a relatively painless method of adjusting the economy.

I hope the scrappers wouldn't object to their new and vital role!

Letters to the Editor

Governor for Diesel Fuel Pump

SIR, We have read with much interest the article on the "French Governor for Diesel Fuel Pumps" (ENGNG., 1 Sept. '61, p. 262).

Having followed the description in connection with the figure we should appreciate more light on the action of the governor.

As we understand it the action would appear to be as follows. It is assumed that the engine is running at its full rated speed and exerting full torque. If the load is thrown off, the delivery of fuel required to keep it running at the same speed will be approximately one-fifth of the delivery at full torque. Since the amount of fuel delivered is proportional to the distance by which the bottom of the piston (6) over-runs the bottom of the "return to tank" port (9), this latter must be cut down to one-fifth of the full stroke of the piston. [The reference numbers in this and the following paragraph refer to the illustration in the original article.]

On the other hand, at a fixed setting of the choke (13) the rate of descent of piston (10) under the action of its spring is constant. The optimum condition for control of the engine is that the piston (10) should just complete its downward stroke in the interval from the end of one injection to the beginning of the next. In that case it will descend one-fifth of the distance in one-fifth of the time. This would appear to imply that in order to cut the fuel delivery down to one-fifth of the full torque quantity the engine must run at five times its full torque speed.

We think that a fuller explanation of the action of the governor would be of interest to many of your readers.

Yours faithfully,
W. A. GREEN.

Green and Fox,
Egham, Surrey.
23 September, 1961.

"Old-Fashioned" View of Work Measurement

SIR, May I refer to the letter from Mr. P. F. Jones (ENGNG., 22 Sept. '61, p. 369), commenting on my article "A Better Way to Reward Workers' Efforts" (ENGNG., 28 July '61, p. 102)?

Once a humble pioneer of work measurement, I find myself less excited than Mr. Jones by the achievements in this field of the past decade. My verdict is that, while it has uses of very real value, its application to rate fixing in the wider field with which I am concerned does not, on the whole, produce results conspicuously better than the considered guesses of experienced foremen.

The reason, I like to give reasons, is that a major factor of the problem, the intimate reaction of the human being and the group, seems likely to remain unmeasureable.

I agree that a large number of workers "enjoy" straight piecework though my reasons might seem cynical to Mr. Jones. I agree, too, that there may be a problem in inducing them to change: it is never easy to get rid of a bad habit. My practice is to set a bonus rate that gives the same earnings for the same output as before; my experience that, properly encouraged, workers will soon exceed that output. Since every extra piece is made for bonus alone the change will not prove unprofitable.

I should have thought that most managements would have more urgent tasks than the development of work measurement techniques but perhaps I am old fashioned in having a bias in favour of simplicity and low overheads.

Since nothing any man or group can do can have more than a "limited value" under this or any day's conditions I am not unduly upset by Mr. Jones's final dictum. My own in exchange would be *solvitur ambulando*, which leads one, when one finds things getting complicated, to try another approach.

Yours faithfully,
EARDLEY BESWICK.

Exeter.
26 September, 1961.

Events in Advance

Forming and Testing of Sheet Metal

FOLLOWING upon the success of last year's meeting in Paris, plans are now in hand for holding a further International Colloquium on the Forming and Testing of Sheet Metal and this event will be held in Düsseldorf on 23 and 24 May, 1962, under the joint sponsorship of the International Deep Drawing Research Group and the Vereins Deutscher Eisenhüttenleute.

It is proposed to devote the open sessions of this meeting to the discussion of two themes: the speed effects of sheet metal forming and the influence of surface conditions on deep drawing. The former will include papers covering such matters as the effect of the speed of deformation in deep drawing or other sheet-forming processes, forming at very high speeds, and explosive forming.

The latter will comprise papers dealing with the effect of surface finish on sheet metal including metallic and non-metallic coatings; the influence of tool surfaces; lubricants and lubrication.

Offers of papers are invited. Details should be submitted before 15 October next and the complete text of accepted papers must be available by 15 January, 1962. Papers may be in English, French or German.

Correspondence regarding the colloquium should be sent to one of the following: Geselschäftsfuhrung des Vereins Deutscher Eisenhüttenleute, 27 Breite Strasse, Düsseldorf, or Mr. John Hooper, secretary, the International Deep Drawing Research Group, John Adam House, Adelphi, London WC2 (Telephone: TRAfalgar 6171).

Exhibitions and Conferences

Arranged in chronological order

German Industries Exhibition, Twelfth.—Sat., 14 Oct., to Sun., 29 Oct., in Berlin. Agent in the United Kingdom: Mr. Neven du Mont, 123 Pall Mall, London SW1. Tel. WHItehall 8211.

Vacuum Science and Technology, Second International Congress.—Sun., 15 Oct., to Tues., 17 Oct., in Washington, DC, USA. Apply to Mr. W. M. Welch, 1515 Sedgwick Street, Chicago, Illinois, USA.

Engineering Display, 14th.—Tues., 17 Oct., to Thurs., 19 Oct., at the Royal Horticultural Society's New Hall, Greycoat Street, London SW1. Organized by the Engineering Industries Association, 9 Seymour Street, Portman Square, London W1. Tel. WELbeck 2241.

Motor Show, 46th International.—Wed., 18 Oct., to Sat., 28 Oct., at Earl's Court, London SW5. Organized by the Society of Motor Manufacturers and Traders, Forbes House, Halkin Street, London SW1. Tel. BELgravia 6611.

Corrosion in the Nuclear Energy Industry: Symposium.—Thurs. and Fri., 19 and 20 Oct., in Paris. The symposium will be held as the 16th meeting of the European Federation of Corrosion and is being organized by the Société de Chimie Industrielle, 28 Rue Saint-Dominique, Paris 7e.

Iron and Steel Institute, Special Meeting in Canada and the United States.—Thurs., 19 Oct., to Tues., 7 Nov. Offices of the Institute: 4 Grosvenor Gardens, London SW1. Tel. SLOane 0061. (Provisional arrangements.)

Forestry, Timber and Woodworking Fair.—Fri., 20 Oct., to Sun., 29 Oct., at Düsseldorf. Organized by the Nordwestdeutsche Ausstellungs-

Gesellschaft m.b.H. (NOWEA), Messegelände, Düsseldorf.

Modern Electronics, Eighth International Fair.—Sat., 21 Oct., to Sun., 29 Oct., at Ljubljana. Apply to Gospodarsko Razstavisce, Ljubljana, Yugoslavia.

Operational Research Society, National Conference.—Tues., 24 Oct., to Thurs., 26 Oct., at Leamington Spa. Offices of the Society, 64 Cannon Street, London EC4. Tel. CITy 1800.

Dairy Show, 75th Annual.—Tues., 24 Oct., to Fri., 27 Oct., at Olympia, London W14. Organized by the British Dairy Farmers' Association, 17 Devonshire Street, London W1. Tel. LANgham 6903.

Problems of Dimensioning and Strength Calculation.—Tues., 24 Oct., to Sat., 28 Oct., at the Hungarian Academy of Sciences, 9 Roosevelt Ter., Budapest V. Apply to Korszerüe Meretezési Konferencia MTA Müszaki Tudományok Osztálya, Nádor utca 7, Budapest V, Hungary.

Saigon International Trade Fair.—Thurs., 26 Oct., to Sat., 25 Nov., in Saigon, South Vietnam. Organized by the Saigon Chamber of Commerce, Tu-do Street, Saigon, South Vietnam. In the United Kingdom, apply to the Economic Department, Embassy of Vietnam, 12 Victoria Road, London W8. Tel. WEStern 3765.

Engineering in Plastics, Conference.—Mon., 30 Oct., and Wed., 1 Nov., at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. Organized by the Plastics Institute, 6 Mandeville Place, London W1. Tel. WELbeck 5439.

Fire Prevention Week, National.—Mon., 30 Oct., to Sat., 4 Nov. Organized by the Fire Protection Association, 31-45 Gresham Street, London EC2. (Telephone MONarch 7412) and the Royal Society for the Prevention of Accidents, 52 Grosvenor Gardens, London SW1. Tel. SLOane 2246.

Canadian National Packaging Exposition, Tenth.—Tues., 31 Oct., to Thurs., 2 Nov., in the Automotive Building, Exposition Park, Toronto. Organized by the Packaging Association of Canada, 1835 Yonge Street, Toronto 7, Ontario, Canada.

Effluent and Water Treatment Exhibition and Convention.—Tues., 31 Oct., to Fri., 3 Nov., at the Seymour Hall, Seymour Place, London W1. Organizers: Thunderbird Enterprises Ltd., 140 Cromwell Road, South Kensington, London SW7. Tel. FREmantle 4063.

Educational Problems of Nuclear Energy, Regional Seminar.—In November, at San Carlos de Bariloche, Argentina. Apply to the International Atomic Energy Agency, Kearntnerring, Vienna 1, Austria.

Materials Handling Convention, Fourth.—Fri. and Sat., 3 and 4 Nov., at the Connaught Rooms, Great Queen Street, London WC2. Theme: "Profit by Handling." Organized by the Materials Handling Group of the Institution of Production Engineers, in conjunction with the Institute of Materials Handling. Apply to the conference secretary, Institution of Production Engineers, 10 Chesterfield Street, London W1. Tel. GROsvenor 5254.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

British Institution of Radio Engineers

LONDON
Symposium of papers on "Digital Differential Analysers." Radar Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 18 Oct., 6 p.m.
LIVERPOOL
"Colour Television," by Dr. G. N. Patchett. Merseyside Section. Walker Art Gallery, Liverpool. Wed., 18 Oct., 7.30 p.m.

Combustion Engineering Association

BIRMINGHAM
"The Case for the Unattended Boilerhouse"; Discussion, to be opened by Hugh Hill and F. D. Brand. Midland Region. Birmingham Chamber of Commerce, 75 Harborne Road, Edgbaston, Birmingham. Wed., 18 Oct., 10.30 a.m.

Diesel Engineers and Users Association

LONDON
"Reclaiming Worn or Damaged Parts of Diesel Engines"; three papers by J. Oswald, N. Tinwell and V. G. Young, respectively. Annual General Meeting. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 19 Oct., 2.15 p.m.

Illuminating Engineering Society

LEEDS
"Office Lighting," by R. G. Hopkinson. Leeds Centre. British Lighting Council, 24 Aire Street, Leeds 1. Mon., 23 Oct., 6.15 p.m.

Institute of Marine Engineers and Royal Institution of Naval Architects

SOUTHAMPTON
"Metallurgy in Marine Engineering," by Dr. J. E. Garside. Southern Joint Branch. Royal Hotel, Cumberland Place, Southampton. Tues., 17 Oct., 7.30 p.m.

Institute of Marine Engineers

BIRMINGHAM
"Fashioned in Steel" (with colour film), by R. C. Benson. West Midlands Section. Queen's Hotel, Birmingham. Thurs., 19 Oct., 7 p.m.
CARDIFF
"Lloyd's Register of Shipping Requirements in the Testing of Welders," by F. B. Bowring. South Wales Section. South Wales Institute of Engineers, Park Place, Cardiff. Wed., 18 Oct., 6 p.m.

Institute of Metals

SHEFFIELD
Film Display. Sheffield Local Section. Applied Science Building, The University, St. George's Square, Sheffield. Thurs., 19 Oct., 7.30 p.m.

Institute of Petroleum

LONDON
"Petroleum in Cosmetics," by T. A. Brock. Fri., 20 Oct., 5.30 p.m.

Institute of Road Transport Engineers

LONDON
Films: "Heroic Days" (History of Motor Racing) and "Motorway", Annual General Meeting of the Institute. Royal Society of Arts, John Adam Street, WC2. Thurs, 19 Oct., 6.30 p.m.
DURHAM
"Automatic Transmission Control Systems for Heavy Commercial Vehicles," by R. B. Robinson. North Eastern Centre. Three Tuns Hotel, Durham City. Tues., 17 Oct., 7 p.m.
EXETER
Technical Films. South Western Group. Headquarters of the City Fire Brigade, Exeter. Wed., 18 Oct., 7.30 p.m.
LIVERPOOL
"Road Safety," by W. Todd. North Western Centre. Merton Hotel, Merton Street, Liverpool. Wed., 18 Oct., 7.30 p.m.
MAIDSTONE
"Oil Additives," by Dr. E. P. Wright. South Eastern Centre. Royal Star Hotel, Maidstone. Wed., 18 Oct., 7.30 p.m.
SHEFFIELD
"Truck Rodeo"; films and technical discussion. Yorkshire Centre. Royal Victoria Hotel, Sheffield. Thurs., 19 Oct., 7.30 p.m.

Institution of Civil Engineers

LONDON
"The Narrows Bridge, Perth, Western Australia," by J. W. Baxter, E. M. Birkett, and E. W. H. Gifford. Tues., 17 Oct., 5.30 p.m.
"Practical Traffic Surveys"; Informal Discussion, introduced by W. P. Haldane. Thurs., 19 Oct., 5.30 p.m.

Institution of Electrical Engineers

LONDON
"The Place of Digital Computers in the Teaching of Electrical Engineers": Discussion, to be opened by Dr. P. D. Aylett. Education Discussion Circle. Tues., 17 Oct., 5.30 p.m.
"Research and Transmission"; Chairman's Address, by Dr. J. S. Forrest. Supply Section. Wed., 18 Oct., 7.30 p.m.
BRIGHTON
"Communication Over a Power Network, with Special Reference to Power Line Carrier," by D. P. Howson and Dr. I. R. Smith. Southern Centre. Technical College, Brighton. Wed., 18 Oct., 6.30 p.m.
CHELTENHAM
"Radiocommunication in the Power Industry," by E. H. Cox and R. E. Martin. Western Centre. North Gloucestershire Technical College, Cheltenham. Thurs., 19 Oct., 6 p.m.
HULL
"Transport and Electric Traction," by G. Streets. North Midland Centre. Offices of the Yorkshire Electricity Board, Ferensway, Hull. Thurs., 19 Oct., 6.30 p.m.
LIVERPOOL
"The 12 MeV Van de Graaff Accelerator to be Installed at Liverpool University," by B. S. Halliday. Mersey and North Wales Centre. Chadwick Laboratory, The University, Liverpool. Mon., 16 Oct., 6.30 p.m.
NOTTINGHAM
"Safety in the Utilization of Electricity," by S. J. Emerson. East Midland Centre. The University, Nottingham. Tues., 17 Oct., 6.30 p.m.
PETERBOROUGH
"Kariba Dam Project: Electrical Installations," by C. J. Dickinson. East Midland Centre. Angel Hotel, Peterborough. Wed., 18 Oct., 7.30 p.m.

Institution of Heating and Ventilating Engineers

HORSFORTH
"Engineer-Architect Collaboration," by G. Grenfell Baines. Yorkshire Branch. Broadway Hall, Horsforth, near Leeds. Wed., 18 Oct., 7.30 p.m.
MIDDLESBROUGH
"Air Conditioning of Operating Theatres," by Dr. R. Blowers. Manchester Branch. Public Health Laboratory, Middlesbrough. Fri., 20 Oct., 6.30 p.m.

Institution of Mechanical Engineers

ABERDEEN
"Recent Developments in Engineering Metrology," by O. R. Hunter. Scottish Branch. Robert Gordon's College, Aberdeen. Fri., 20 Oct., 7.30 p.m.
BELFAST
"Quality Control and Reliability," by F. Nixon. Northern Ireland Branch. College of Technology, Belfast. Tues., 17 Oct., 6.30 p.m.
EDINBURGH
"Recent Developments in Engineering Metrology," by O. R. Hunter. Scottish Branch. North British Hotel, Edinburgh. Thurs., 19 Oct., 6.30 p.m.
READING
"Direct Conversion of Heat to Electricity," by P. D. Dunn. Southern Branch. Small Town Hall, Reading. Tues., 17 Oct., 7.15 p.m.

Institution of Mining and Metallurgy

LONDON
"Mining Practice on the Kolar Gold Field, India," by J. T. M. Taylor. Geological Society, Burlington House, Piccadilly, W1. Thurs., 19 Oct., 5 p.m.

Institution of Plant Engineers

LONDON
Colour Films. London Branch. Royal Society of Arts, John Adam Street, WC2. Tues., 10 Oct., 7 p.m.

Institution of Production Engineers

BIRMINGHAM
"Recent Developments in Mechanical Transfer for Machines and Assembly," by H. Bezier. Birmingham Section. Midland Hotel, Birmingham. Wed., 18 Oct., 7 p.m.
BRIGHTON
"Modern Trends in Machine Tool Design", by E. R. Cash. London Section. Old Ship Hotel, Brighton. Wed., 18 Oct., 7 p.m.
HALIFAX
"Machine Tool Development in the USSR", by N. Stubbs. Halifax Section. Engineering Tower, Halifax Technical College, Halifax. Tues., 17 Oct., 7.30 p.m.

Institution of Structural Engineers

MANCHESTER
Chairman's Address, by J. B. Story. Lancashire and Cheshire Branch. College of Science and Technology, Manchester. Tues., 17 Oct., 7 p.m.
NEWCASTLE UPON TYNE
Chairman's Address, by L. Dobson. Northern Counties Branch, Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 16 Oct., 6.30 p.m.

Junior Institution of Engineers

LONDON
"Recent Trends in Telecommunications", by R. A. Hill. Fri., 20 Oct., 7 p.m.

North East Metallurgical Society

MIDDLESBROUGH
"Causes and Prevention of Service Failures in Railway Equipment", by J. Dearden. Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough. Tues., 17 Oct., 7.30 p.m.

Reinforced Concrete Association

LONDON
"Tropical Architecture: The Development of Reinforced Concrete in West Africa", by E. Maxwell Fry, Royal Institute of British Architects, 66 Portland Place, W1. Wed., 18 Oct., 6 p.m.

Royal Institution of Chartered Surveyors

LONDON
"Recent Experience in the Use of Airborne Profile Recorder", by P. G. Mott and J. A. Eden. Thurs., 12 Oct., 5.45 p.m.

Royal Statistical Society

GLASGOW
"New Uses of Computers in Statistics", by Professor G. A. Barnard, Glasgow Group. Royal College of Science and Technology, Glasgow. Thurs., 19 Oct., 7.30 p.m.

Sheffield Metallurgical Society

SHEFFIELD
"Wrought Aluminium Bronzes: Rivals to Stainless Steels?" by C. V. Wilson. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 17 Oct., 7 p.m.

Society of Chemical Industry

LONDON
"Volatile Corrosion Inhibitors". (i) "Principles", by E. Ll. Evans. (ii) "Practical Applications", by K. H. Gibbons. Wed., 18 Oct., 6 p.m.

Society of Instrument Technology

LONDON
"The Inspiration of Science," by Sir George Thomson. The Thomson Lecture. Royal Institution, Albermarle Street, W1. Thurs., 19 Oct., 6 p.m.
BRISTOL
"Instrumentation and Control at the Hinkley Point Nuclear Power Station", by R. B. Quarmby. Bristol Section, Department of Physics, Bristol University, The Royal Fort, Bristol. Tues., 17 Oct., 7.30 p.m.
GRANGEMOUTH
"Computers", by J. Keay. Grangemouth Section. Leapark Hotel, Bo'ness Road, Grangemouth. Thurs., 19 Oct., 7 p.m.
NEWCASTLE UPON TYNE
"Design of Instruments and Control Panels", by A. A. Ardley. Newcastle Section. Roadway House, Oxford Street, Newcastle upon Tyne. Wed., 18 Oct., 7 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
Presidential Address, by Dr. R. Hunter. Thurs., 19 Oct., 6.45 p.m.

British Institution of Radio Engineers, 9 Bedford Square, London WC1. (MUSeum 1901)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London W1. (LANgham 3583)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London SW7. (KENsington 3744)
Institution of Civil Engineers, Great George Street, London SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. (COVent Garden 1871)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London SW1. (VICtoria 0786)
North East Metallurgical Society. Apply to Mr. W. H. Lowther, 5 Priestfield Avenue, Ladgate Lane, Middlesbrough, Yorkshire.
Reinforced Concrete Association, 94-98 Petty France, London SW1. (ABBey 4504)
Royal Institution of Chartered Surveyors, 12 Great George Street, London SW1. (WHItehall 5322)
Royal Institution of Naval Architects, 10 Upper Belgrave Street, London SW1. (BELgravia 4622)
Royal Statistical Society, 21 Bentinck Street, London W1. (WELbeck 7638)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Chemical Industry, 14 Belgrave Square, London SW1. (BELgravia 3681)
Society of Instrument Technology, 20 Queen Anne Street, London W1. (LANgham 4251)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow C.2. (Central 5181)

Human Element

Management Case Studies

A prime essential in making any course of management training live and really have immediacy for the course members is a supply of good and illustrative case studies. As management training has become more and more widely practised so the demand for such case studies has increased.

Finding that this demand has now seriously overtaken the supply, the British Institute of Management South London Branch are holding a second conference (the first was held a year ago) next weekend, from 13 to 15 October, on "The Preparation and Use of Case Studies." It will be held at the BEA Staff College at East Burnham, Slough, and is organized in conjunction with the Comparative Administration Trust, one of whose objects in life is the promotion of case study work as a method of training.

The course will be opened and closed by the branch chairman, Mr. J. G. Landgrebe, a former director of Production Engineering, the management consultants, and there will be a high powered team of speakers. These will include Mr. Bowman Scott, of Solartron, Mr. D. Smith, past chairman of the South London Branch, Mr. Z. M. T. Tarkowski, the author of a new series of case studies, and Dr. S. A. Young, Chief Scientist of Atomic Power Constructions and Chairman of the Comparative Administration Trust. The conference secretary is Mr. B. E. Baldrey, of Palmer's Travelling Cradles and Scaffold Limited.

There will be detailed critical discussion of two new case studies, and it is hoped to formulate criteria for evaluating the suitability of various case studies for particular types of course, as a guide for their preparation.

It is a lengthy and difficult business producing case studies and, therefore, it is probably expecting too much to hope for dramatic results from the conference. Meanwhile, there might be scope for setting up a register of case studies so that the available material can be used as widely as possible until new studies are ready for use. The shortage of case studies might be a problem of distribution as well as of production.

Strikes Out, Accidents Down

When the National Joint Industrial Council for the Rubber Manufacturing Industry completed 21 years of operation last week, it was able to make the proud boast that throughout that time there had not been a single official strike in the industry. In an industry less technically progressive than the rubber industry (which has had to keep up-to-date, if only to meet the demands put upon it by increased car and aircraft performance, for example) this might have been taken as a mark of technical stagnation as much as one of progressive industrial relations.

The rubber industry's clean record on strikes, however, is largely a product of the sensible realization that technical advance has to take account of the human factor. At the NJIC's coming of age party, the Minister of Labour, Mr. John Hare, quoted the example of the joint inquiry carried out earlier this year by Dunlop and the TGWU into labour relations at the Dunlop factory at Speke when it was felt that these relations were deteriorating.

Though much of the council's time has been devoted to establishing fair wages and conditions and an effective negotiating procedure, one of its most important developments has been the formation of an accident prevention committee which analysed 26,000 accidents over several years as a first step towards reducing industrial injuries and accidents. Management and managed then cooperated in implementing the committee's subsequent accident prevention policy to such good effect that the amount of time lost through accidents has been reduced to 1·1 per 100,000 man hours. A two years survey has also been made by the Rubber Manufacturing Employers' Association of sickness absence at 50 firms.

Though it has been generally considered in the past that the type of work common in the rubber industry does not lend itself to apprentice training, such training has now been set up leading to a City and Guilds examination. Thus, the rubber industry, already very enlightened in industrial relations generally and in accident prevention, is now making up what might be taken to be leeway in the field of industrial training and education.

Taking Management Out of Itself

More and more firms are adopting the practice of organizing management conferences. These gatherings, in spite of occasional cynicism about drinks and a high life for the boys, can perform an invaluable function in taking managers out of themselves, enabling them to get away from their everyday commitments and responsibilities and to take a more objective look at their place in company policy. It is often the case, even, that two members of management who see each other every day will gain a better understanding of their interrelationship at such a conference than they ever can in the telephone-ridden turmoil of their normal working lives.

Last week, for example, the David Brown organization held their second management conference—taking up one weekend—at Harrogate. They heard papers on "The Economic Problems of the 1960's," "Home and Overseas Manufacture—the Problems of Financing Expansion," "Marketing in the 1960's," and "Trends in Industrial Organization." The speakers were Mr. W. Manning Dacey, Economic Adviser to Lloyds Bank; Mr. R. S. Cranston, Industrial Adviser to M. Samuel and Company; Mr. Aubrey Wilson, Managing Director of Industrial Market Research Limited; and Professor T. E. Chester, of Manchester University.

Clearly, these were subjects and speakers that would usefully exercise the ideas and vision of any management team, and there was plenty of opportunity for questions and discussion. This is very important, for a firm can only act as big as its managers can think.

The apprentices' new hall of residence at Stewarts and Lloyds, Corby.

Hall of Residence for Apprentices

Last month, Stewarts and Lloyds' new residential hall for apprentices at Corby, Northants, was opened by one of the group managing directors, Mr. L. M.T. Castle. This hall cost about £150,000 and will provide accommodation for 65 apprentices, including student apprentices (the majority), commercial student apprentices, technical and craft apprentices, and undergraduates on vacation courses.

Each will have a study-bedroom designed as a self contained unit, with a fitted wardrobe, cupboard and a separate toilet section and shower. The building also has a games room, lounges, and a sick bay. An entrance foyer connects the main building to the dining room and staff block, and there is a small garage block and a tennis court.

Most of those in residence will be young men in the firm's student apprenticeship scheme to which the minimum standards of entry are those required for entry to a university or to a course leading to a Diploma in Technology. A number of students are on four or five year "sandwich" courses, dividing their time between the works and a College of Advanced Technology. Others spend an initial year of training at the works, three years at a university and then a final year at the works.

Such halls of residence as that at Corby can be a sound investment for a company now that it is becoming more and more common for bright young men to seek apprenticeships far from home. They can help to give works based apprentices some of the advantages of the corporate life enjoyed by undergraduates.

Apprentices' Academic Attainments

Three of the ten first class honours degrees in mechanical engineering awarded by London University at the end of the last academic year were awarded to former Dowty Group apprentices. Two other Dowty people obtained second class degrees. All five of them studied for their degrees at the North Gloucestershire Technical College, in Cheltenham.

Their attainments can be taken to reflect the successful methods of training, education and selection used by the group—methods which have attracted a high standard of candidate not only from the locality but also from other parts of the country and overseas. At present 630 apprentices are under training with the group in four main streams, for graduate apprentices recruited direct from the universities; for student apprentices, chiefly with advanced and scholarship level GCE in mathematics and physics; and for technical and craft apprentices.

Initial selection of apprentices is based on up-to-date psychological and aptitude testing which has been so effective that wastage during training has been less than one-half per cent. A mark of the apprentices' satisfaction is that over 70 per cent of them remain with the group after completing their training.

Full Training

The new Pressed Steel training centre at Cowley, opened by Mr. W. J. Carron on 20 September, is far more than a craft apprentice school. It is a training centre for foremen, supervisors and graduate apprentices as well, and there are facilities for a course in trade unionism—the first in the motor industry—in which the responsibilities as well as the rights will be taught. In fact, sound human relations is one of the ideals of the project.

Craft apprentices come to the centre direct from school, and to continue the school outlook there is a gymnasium where all students will spend two one-hour periods a week. The exercises are arranged in graded courses so that as one is completed the student moves on to others a little harder; all are designed to train the muscles used in the craft for which the student is preparing. Apprentices are also encouraged to participate in the Duke of Edinburgh's award scheme and it is expected that this year there will be some twenty entrants.

The centre will also train employees for posts in higher management. These will be drawn from inside the company, from any of the four works (in fact, the system has been in operation for some while already) and will be trained to follow in the places of those who retire. One of the proudest records of Pressed Steel is the small staff turnover and the amount of long service in all departments. Replacement of men retiring is not a haphazard matter but is planned a long while ahead. This allows time for choosing the right man, instead of having to make a snap decision at the last moment. With a total payroll in the neighbourhood of 23,000 and interests in the motor, refrigerator, railway and aircraft industries, the training centre should ensure a smooth flow of talent.

LIQUID SEPARATOR

Removes Suspended Matter

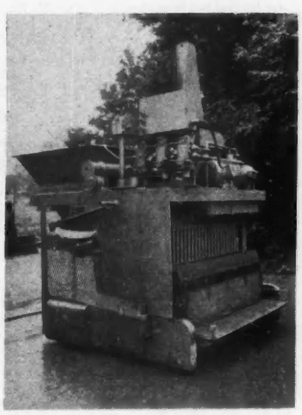
ABLE to remove suspended matter from liquids, the Daynor separator will produce a clear sediment-free water from sources containing a high proportion of particles in suspension. This separator has had a considerable application in Europe but is only now available in Britain.

Operating on the hydro-cyclone principle, the separator is claimed to occupy approximately one-sixtieth of the area of a rotating clarifier of the same capacity. Loss of head through the separator is reported to be small. The device cannot choke, is subject to little wear, requires no skilled operation, and needs inexpensive foundations.

An inverted steel cone has a cylindrical portion at its upper end. This cylinder is divided into two chambers. Unclarified liquid enters tangentially below the dividing plate. The vortex created by the tangential inlet imparts radial velocity to particles in suspension and when carried beyond a critical radius they pass down to the lower end of the cone, whence sludge is drawn off. The treated water leaves through an outlet in the upper chamber. *Water Engineering Limited, 33 Dorset Square, London NW1.*

BLOCKMAKING MACHINE

High Output



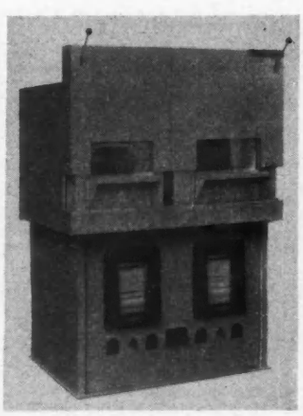
THE Multibloc Major concrete block-making machine is capable, when working at three cycles per minute, of outputs of 2,000 four inch solid blocks per hour.

Simple control is said to be a feature of the machine, which is designed for one-man operation. Constructed of channel sections and plate the unit runs on four cast-iron wheels. The driving axle is solid to give straight running. The mouldbox frame and tamper are lifted by hydraulic rams, on top of the frame, acting on horizontal beams across the machine. The feedbox moves horizontally along channels on either side of the mouldbox frame. The fabricated hopper has a heaped capacity of 1 cu. yd and holds enough aggregate to make 5 drops of 4 in by 8⅝ in by 18⅞ in blocks, equivalent to 60 blocks.

Compaction of the aggregate in the mould is achieved by a combination of vertical blows from the tamper and vibration from the twin high-frequency vibrators. Automatic traction is started by a limit switch, operated by the mouldbox when at its maximum height. Running continues until a pneumatic-type timing relay cuts off current. If desired the automatic traction may be switched out and manual control substituted. *Welding Industries Limited, Blackswarth Road, Bristol 5.*

TOOL-ROOM FURNACE

Twin Chambers



SERIES E 1400 TCEF twin-chamber electric tool-room furnaces have a preheating chamber (1,000° C) and a high-temperature chamber (1,400° C).

These furnaces are reported to be suitable for heat treatment processes and tests in the laboratory or research department, as well as for production use in the tool room or workshop. Heating is said to take place uniformly and adjustment over the operational range is simple.

The heating elements are claimed to be easily replaceable, being of a moulded-embedded type in the pre-heating chamber and a silicon carbide type in the high-temperature chamber. The stand upon which the furnaces are mounted houses the control and switchgear. The temperature in each compartment is maintained by individual strip-type recorder controllers, but simplified forms of control are available. Control may be manual or automatic.

Dimensions of the preheating chamber in the example illustrated are 9 in wide by 6 in high by 18 in deep. The high-temperature chamber is 6 in wide by 4½ in high and has a depth of 12 in. The furnaces are available in other sizes and combinations. Power consumption is approximately 15 kW on a 400/440 V 3 place 50 cycles supply. *Barlow-Whitney Limited,2 Dorset Square, London NW1.*

ULTRASONIC THICKNESS GAUGE

Direct-Reading

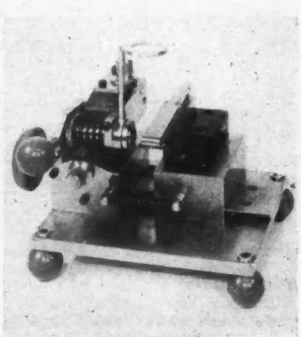
THE Type 1103 transistor ultrasonic thickness gauge is claimed to be especially suitable for work which requires rapid and simple measurement of material thickness in awkward locations, and to which there is access from one side only.

Features of the gauge are its lightness (4¾ lb), and its direct meter indication of thickness. The material-selector switch gives immediate readings with steel, aluminium, and copper. Other materials, including most metals, glass, plastics, and ceramics can be tested by using the undesignated switch position and calibrating on a known thickness of the material.

The equipment consists of an all-transistor oscillator which generates waves converted into mechanical vibrations transmitted to the workpiece. The vibration frequencies at which resonance occurs are found by noting the accompanying increases in the headphone audio signal and in the output-meter deflection. In a given material the resonant frequencies are directly related to the thickness and values from 0·09 in to 5 in can be read directly. Accuracy is to within 3–5 per cent of the wall thickness. The instrument is said to be simply operated and to be suitable for both flat and convex surfaces. Power is derived from three Mallory type TR 233 dry batteries. Dimensions of the unit are 9¼ in by 4⅜ in by 4½ in. *Dawe Instruments Limited, Harlequin Avenue, Great West Road, Brentford, Middlesex.*

WIRE WELDER

Butt Joins Fine Wires



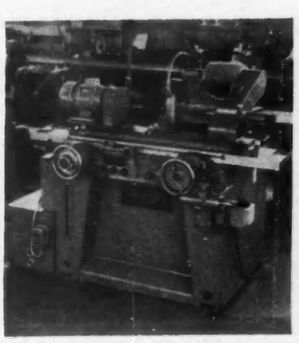
THIS precision butt welder for fine wires is intended for use in conjunction with the makers' standard capacitor discharge power pack. It is able to weld similar and dissimilar metals.

Accurate concentric alignment of wires from 0·040 in down to 0·006 in in diameter is reported to be obtainable. Two wire-holding members are mounted on the common base. The stationary component carries a quick-releasing collet, which by means of the micrometer-controlled slides can be aligned in two planes. The moving component has a sensitive clamp mounted on it for securing the second wire which can differ in diameter from the first wire. Both components are insulated from the base and are provided with electrode leads for connection to the power pack.

When the wires are loaded with a finite gap between them, and the correct voltage and capacity settings have been made, welding is carried out by rotating the controlling screw which brings the ends together and completes the discharge circuit. Alignment is facilitated by the magnifying head, rotatable through 90°. If preferred, a twin viewing head can be fitted, together with a positional device which permits the welding machine to be rotated through an angle of 90°. This equipment has the object of minimizing operator fatigue. For certain types of production work a more advanced version is available for automatic welding. *Spembly Limited, 13 New Road Avenue, Chatham, Kent.*

CYLINDRICAL GRINDER

Separate Drives



SIMILAR to the Type OIU, the Johansson cylindrical grinding machine added to the maker's range has increased capacity, having 10 in swing against the 8 in of the type previously available. The distance between centres remains at 16 in. The normal grinding length is 14 in.

Separate motors drive the grinding head, work head, hydraulics, and internal grinding spindle. The machine can accommodate components up to 44 lb in weight with the tailstock unlocked; with steadies a maximum weight of 165 lb can be taken. The minimum grinding-wheel diameter is 5 in and the maximum 14 in. The grinding head swivels through 17° in either direction. The machine is offered with either ball or plain bearings. The grinding head has a 3kW motor and has speeds of 1,750 and 2,500 rpm. The headstock motor has variable-speed control from 0 to 700 rpm in both directions of rotation. The headstock swivels through 20° clockwise and through 135° in the anticlockwise direction. The table swivels by 12° towards the grinding head and by 3° away from it.

Table-travel speeds are infinitely variable from 5 in per minute to 8 ft per minute. Reversing precision to a dead stop is 0·0004 in when using hydraulics. The dwell period can be varied at either end of the table from 0 to infinity. *Stuart Davis Limited, P.O. Box 21, Stone Bridge Highway, Willenhall, Coventry, Warwickshire.*

VIBRATOR

Locates Car Noises

ACCURATE and speedy location of squeaks and rattles in cars, without moving the car from the garage, is said to be facilitated by the ME vibrator.

By transmitting vibrations to the chassis over a wide range of controlled frequency, the vibrator emulates conditions normally induced by the engine and transmission over their speed range when the vehicle is in motion on the road. The machine consists essentially of a variable-speed electric motor coupled to a vibrator housing and an eccentric shaft carried on ball and roller bearings. One end of the vibrator anvil is in contact with a ball bearing on the eccentric portion of the shaft. As the motor and shaft revolve an oscillatory movement of the anvil is set up, creating a controlled vibration.

To test a vehicle, the vibrator is positioned under a part of the body skirt and the vibrator anvil brought into firm contact, using a screw adjuster. The machine is switched on and the periodicity of the vibrations adjusted and fixed as

required by the remote flexible hand control, which may be led inside the car body. *Mann Egerton and Company Limited, 5 Prince of Wales Road, Norwich.*

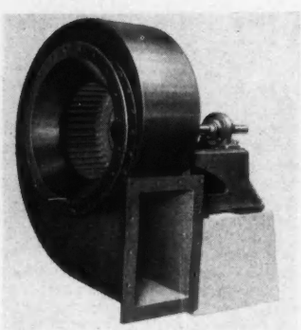
CENTRIFUGAL FAN

General Industrial Application

THE new Sirocco U Type centrifugal fan is a belt-driven unit of the free-standing type. Manufactured in three runner designs and twelve sizes the fan is stated to be suitable for the greater majority of fan applications.

The unit, of the wide-casing type, is claimed to have a high volumetric capacity which varies to a small extent only. The UFB70 is a general purpose fan suitable for the handling of clean air or gas, although small amounts of suspended matter in the air or gas are reported to have no harmful effects. The design may be used for high-velocity heating and ventilating or air-conditioning schemes. The fan is also suitable as a forced-draught or induced-draught one on boilers of the Lancashire or Economic type.

Similar fields of application are covered by the UBCB, which is said to have a slightly higher efficiency where high power consumptions are involved. It can handle gases containing some suspended matter and is suitable as an



exhaust fan for kilns, furnaces, or boilers calling for a relatively high pressure. As a general rule this fan and the UFB70 are not recommended where the gas entering contains more than 3 gr per cu. ft of abrasive matter.

The UBAB Type is claimed to have high efficiency and to be particularly suitable for larger duties, particularly the supply of forced draught to a boiler or combustion air to a furnace. *Davidson and Company Limited, Sirocco Works, Belfast.*

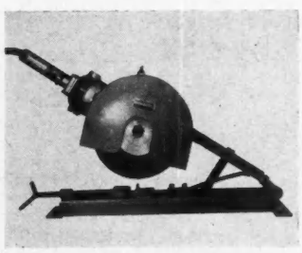
CUT-OFF MACHINE

Fully Portable

NAMED the Portacutta, this new lightweight fully-portable cut-off machine is claimed to have ample power for cutting angle iron, tube, steel strip, bar, or conduit tube and cable.

The unit, weighing 48 lb complete, can be mounted on a bench or on a folding floor stand which can be supplied as an extra. The recommended production cutting limits are $\frac{3}{4}$ in square mild steel, $1\frac{1}{2}$ in by $1\frac{1}{2}$ in by $\frac{1}{4}$ in angle iron, and 2 in by $\frac{1}{4}$ in mild steel strip. Typical cutting times are reported to be 10 seconds for square mild steel of the size mentioned, 8 seconds for the angle-iron referred to and 4 seconds for steel strip $\frac{3}{4}$ in by $\frac{1}{4}$ in. Electrical conduit 1 in in diameter may be cut through in 3 seconds. The built-in swivelling vice enables mitre cuts to be made.

For an input of 1,060 W the $1\frac{1}{2}$ hp Black and Decker power unit gives 6,000 rpm. Models are available for 32, 50, 110, 200/220, and 230/250 V. Normally a 10 in by $1\frac{1}{8}$ in by $\frac{1}{16}$ in cut-off wheel is supplied but wheels for hard



rubber and plastics can be supplied in addition to those for metal. A modified machine has a 10 in slitting saw running at 4,200 rpm for cutting extruded aluminium sections.

The machine, which incorporates a welded-steel base and quick-release guard, is 19 in high overall, 10 in wide, and $28\frac{1}{2}$ in long. All motor bearings are dust-sealed. Standard equipment includes flanges of 5 in and 3 in diameter, together with adaptors. A modified version of the machine can be supplied for cutting steel-reinforced high-pressure rubber hose. *Pee-Cee Engineering Supplies Limited, 115 West Street, Bristol 3.*

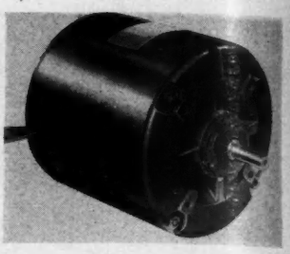
MOTORS

Fractional Horse-Power

COMPLYING with the requirements of BS 170 and having mounting dimensions of American standard NEMA 42, the T30 range of fractional horse-power motors has been produced.

These compact motors are said to be specially suitable for office appliances such as calculating machines, computers, and duplicators. They are also applicable to fan drives on air-conditioning plant, cooler units, and laboratory equipment. Four main types are available, shaded pole, capacitor start induction run, capacitor start and run, and splitphase start. All types are available with drip-proof enclosure, and the shaded-pole motor can be supplied as totally-enclosed airstream and totally-enclosed still air rated.

The range provides for all-angle mounting. Methods include resilient base, resilient rings without base, endshield pad with tapped holes and endshield pad with extended studs. Those motors with resilient base have a centre height of only $2\frac{5}{8}$ in. To comply



with NEMA standards the shaft extension is of $\frac{5}{8}$ in diameter, but bearings allow for $\frac{1}{2}$ in diameter shafts to be provided. The oil wells are reported to hold oil for two years normal running.

Split-phase, and capacitor start induction run motors have a starting relay separately mounted. Capacitors for capacitor start induction run, and capacitor start and run motors are also separate. The range is available for single-phase working from $\frac{1}{40}$ hp at 1,350 rpm as a shaded-pole totally-enclosed still-air motor, up to $\frac{1}{3}$ hp at 1,425 rpm as a split phase or capacitor motor. *Crompton Parkinson Limited, Aldwych, London WC2.*

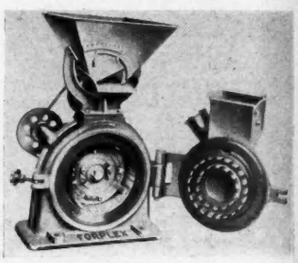
GRINDING MILL

Elements Interchangeable

DESIGNED for the processing of materials in the soft to medium-hard range, the Forplex mill is claimed to be able to grind a wide range of products.

This versatility results from the grinding elements being interchangeable, which permits various outputs from one model. Changing elements is said to be done rapidly, access being through the door on the face of the mill chamber. The grinding process is performed by a rotor with concentric hammers running between the teeth of a disc located on the door. The particles of material being ground are subjected to continuous and frequent attrition between the high-speed rotary and the static grinding elements and are thrown against a drum surrounding both grinding elements.

The draught created by the rotating assembly expels fine particles through the screen while the coarse or partially-ground material is forced back for further breakdown. If it is required to reduce the material to below the sieve range multiple-pin elements are used



and the particle size can be controlled by varying the speed of rotation. This arrangement is said to be effective in the case of substances which tend to clog the screen. An automatic and adjustable feeder incorporates an electromagnetic separator.

Capacities range from 14 lb to 3 cwt per hour (according to the material processed) in the case of the Model FO, to 5 tons per hour in that of the Model F4. Materials which can be processed include foodstuffs, chemical products, and pharmaceutical and biological products. The mill is of compact size. *Russell Constructions Limited, Adam Street, London WC2.*

BLOWER-SUCTION FAN

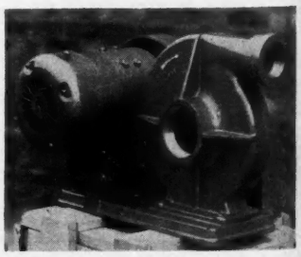
High Velocity

NEWLY introduced, the Secomak Model 428 high-pressure centrifugal fan is driven by an ac induction motor.

It is claimed that the air movement of the fan surpasses that provided by a fan powered by a series-commutator motor and that there are not the same maintenance problems. It is also stated that the space required by the Secomak fan is but one-half or one-third of that occupied by a conventional ac directly-driven fan. Drive is transmitted from the motor to the fan by a nylon belt which is automatically tensioned.

The fan, which is intended for continuous duty, will deliver 100 cfm at 27 in wg, 200 cfm at 25 in wg, and 300 cfm at 22 in wg. The overall size is $21\frac{3}{4}$ in by $13\frac{3}{4}$ in by 13 in. The motor, which can develop $1\frac{1}{4}$ hp, operates on a 380/440V 3 phase 50 c/s supply. In addition to usual uses it is said that the unit is applicable to monitoring radioactivity in the atmosphere, sampling flue gases, and fluidizing closely-packed powders.

The Secomak Model 350 is a smaller



model. Having a motor able to develop $\frac{1}{8}$ hp, it can deliver 10 cfm at 4·8 in wg, and 37 cfm at 1·1 in wg. Overall dimensions are $10\frac{1}{2}$ in by $6\frac{3}{4}$ in by $12\frac{1}{2}$ in. *Service Electric Company Limited, Honeypot Lane, Stanmore, Middlesex.*

The illustration accompanying the description of the mine car loader (ENGNG., 22 Sept., p. 375) was in fact that of a hollow ventilating gummer bar. This device, for ventilating the undercut made by coal-cutting machines, is the subject of experiments which are being conducted by the National Coal Board's Central Engineering Establishment, Stanhope Bretby, Nr. Burton-on-Trent.

EXHIBITIONS AT OLYMPIA, LONDON

Business Efficiency 3-11 October

Computer 3-12 October

Two exhibitions of considerable value to the engineering world are currently open at Olympia.

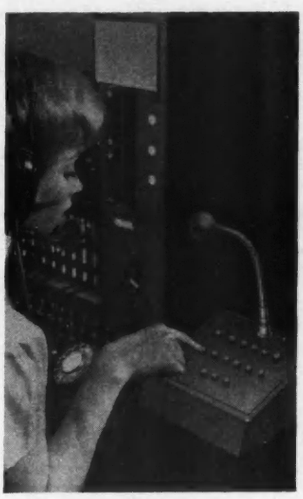
The 49th National Business Efficiency Exhibition provides an opportunity for those responsible for administration to see a comprehensive range of office equipment. Not only does the engineer use many of the modern aids to efficiency but he plays a large part in their design and construction. Among the many items on view are electronic calculators, printing and composing machines, charting and planning boards, dictating equipment, furniture, and machines for opening mail. The importance of the industry may be gauged from the fact that exports of office equipment during the first six months of this year exceeded £20 million.

The 2nd Electronic Computer Exhibition comes three years after the first. Viewed in terms of development, the difference between them is considerable for much has been done in both the design of equipment and its application in the intervening period. The technical advances made, backed by the experience of users, have placed in the hands of management tools for achieving integrated control by more compact and powerful methods. The new systems and the work that they make possible are being demonstrated at the exhibition.

Some of the equipment now on view at Olympia is described on this page.

PAGING SYSTEM

Low-Frequency Signal



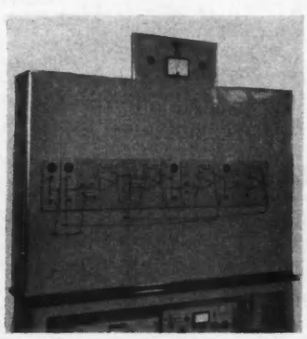
CAPABLE of locating personnel within any given area, the Modernphone paging system transmits a distinctive call signal followed by a spoken message.

A simple control panel (illustrated) at the telephone switchboard incorporates a small microphone. The operator selects any one of up to 210 receivers by depressing two buttons in the panel, which may be desk or wall mounted. The signal transmitted is a low-frequency modulated RF one, in the inductive loop, which is said to offer advantages in many forms of building construction.

The receiver is a printed-circuit transistorized one housed in a shock-proof plastic case with a clip to secure it in a pocket. The size is approximately 5½ in by 2¼ in by ⅞ in. The weight is 5 oz. In operation a distinctive call sign is followed by the spoken message; if desired the call sign may take the form of a flashing light. The receiver battery can be charged in off-duty hours and, for this purpose, individual or 30-way charging units are supplied for operation from mains voltage. When being charged the receiver responds to calls in the normal way. *Modern Telephones (Great Britain) Limited, Olding's Corner, Hatfield, Herts.*

ANALOGUE COMPUTER

Educational



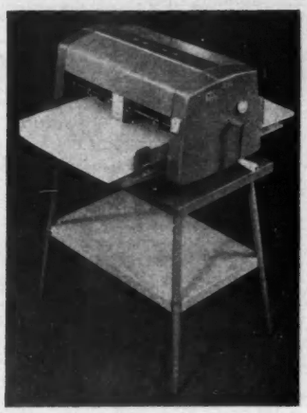
THIS new analogue computer has been developed to meet the present trend towards the introduction of computing techniques into the curricula of universities and technical colleges. While it is basically an educational instrument it may also be used for serious research.

The computer is claimed to combine simplicity and flexibility with economy, reliability, accuracy and ease of presentation. Its component accuracy is reported to be 1 per cent. The standard machine has a capacity of 8 amplifiers. As can be seen from the illustration, the components required for a particular problem are plugged into the computer base and a circuit diagram of the problem is presented on the face of the instrument. This procedure is said to alleviate the normally difficult transition from purely theoretical study to operation of an advanced computer.

Separate oscilloscope and power units are used with the computer, as these are normally available in technical colleges and electronic laboratories; should they be required, however, they can be supplied. The capacity of the computer may be extended to 15 amplifiers, but as the number of amplifiers increases fewer scaling units can be plugged. Power requirements are stabilized ± 300V, 350 ma. 230V ac. Dimensions of the computer board are 65 in by 42 in by 8 in. *Short Brothers and Harland Limited, Precision Engineering Division, Castlereagh, Belfast.*

ELECTRIC DUPLICATOR

Uses Colours



KNOWN as the 550 Policy model, this new table-model electric duplicator has been introduced to fill a need for a competitively-priced electric model in the makers' Policy range.

This duplicator can handle any size of paper from octavo (8 in by 5 in) to policy (18 in by 14 in). It is reported to be able to print with precise registration on a maximum area of 17 in by 13 in. The fully-automatic inking system uses the Roneo perforated cylinder method of ink distribution; this is claimed to reduce inking costs to a minimum. The cylinder is capable of holding up to 2 lb of ink, which is said to be sufficient for printing about 20,000 copies. Inks in a range of up to 14 colours are available. For colour printing the cylinder is easily changed; the replacement cylinder containing the selected colour may be fitted in about 25 seconds.

The machine is simply operated, two switches covering feed and power requirements. An automatic counter, for quantities up to 999, automatically cuts the machine out when the desired number of copies has been printed. The duplicating speed is 60 copies per minute, irrespective of the size of paper used. *Roneo Limited, 17 Southampton Row, London WC1.*

DICTATING MACHINE

Magnetic Disc

THE Agavox Model 2 is a new magnetic-disc dictating machine. Having a height of only 3 in, it will easily go into a briefcase.

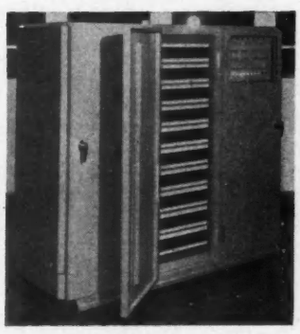
Transistors, printed circuits, and other technological advances are said to have contributed to the machine's lightness, ease of operation, and reliability. All controls which the dictator requires to use are on the microphone; these allow change from dictation to playback and, by remote control, mark the ends of letters and corrections on the index strip. On playback, it is possible to go back to any part of the recording and to hear it any number of times. Reproduction is said to be clear in the built-in loud speaker, the microphone, and in the typist's headset. There are controls for adjusting the input and output volume.

A number of protective devices have been incorporated to ensure that there is no likelihood of mis-operation. As an example, the typist can play back at slow speed; but, if the machine is subsequently switched over for dictation, the slow speed control cancels itself. An erase control is said to clean a disc in a few seconds; this device has a safety catch to avoid inadvertent operation. The telephone-recording control is inoperative unless the telephone attachment is plugged in.

The plastic discs are said to be unbreakable and to be usable at least 20,000 times. The machine can be used in a car with the aid of a vibrator unit and may also be employed in connection with the makers' remote control dictation-by-telephone equipment. *Aga Dictating Machine Company, 146 New Cavendish Street, London W1.*

PROCESS-CONTROL COMPUTER

Transistorized



THE Argus is claimed to be a fast and powerful digital computer which is intended for the direct control of industrial processes.

Its time-sharing facility is said to make it capable of storing and working on several programmes at once and dealing with several different plants or processes concurrently. A wide range of applications, ranging from data-logging to direct control, is reported to be within the computer's scope. Linked to conventional plant instruments and controls, information can be read into the computer from several hundred locations, subjected to any necessary mathematical operations, and then used to generate any desired number of output signals, for direct plant control, plant supervision, or for the operation of logging devices.

In addition to its use for process control, the Argus computer can aid production research. A peg-board storage system is used, in which programmes are set up manually, but it is stated that this in no way affects the machine's versatility as a computer.

The basic computer is of the binary, serial/parallel, fixed point type. It has modified single-address, with multiple accumulators. Word length is sign + 11 binary digits + parity digit. Facilities for optional 24-bit working are standard. The pulse repetition rate is 2 microseconds. The basic computer alone measures 72 in by 60 in by 24 in and weighs 1,000 lb. *Ferranti Limited, 68 Newman Street, London W1.*

British Racing Car and Engine Developments

By Brian Lister

It is a good time to look back on the present motor racing season, with the world championship no longer in doubt, and only one Grande Epreuve left for 1961, the Grand Prix of the USA to be held at Watkins Glen on 8 October.

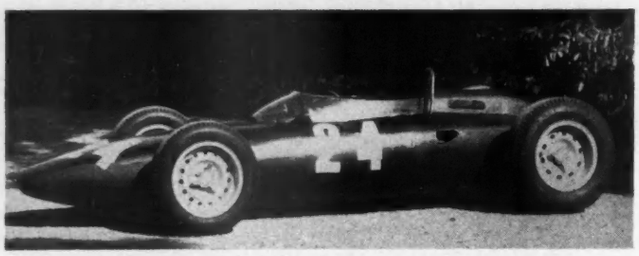
Throughout the season Ferrari, who planned their Grand Prix cars well in advance of the formula, have reigned supreme. They have won all the international Grandes Epreuves with the exception of the German and Monaco races; both of these events were won by Stirling Moss on a Lotus fitted with a 1½ litre 4 cylinder Coventry Climax engine. This indicates the amazing driving superiority of Moss over all the other leading drivers of today, and the results also underline the lead of Ferrari in engine development. There are now signs that British constructors could regain the lead in first division motor racing next year.

Jack Brabham, 1960 world champion, received the first of the 1½ litre V8 Coventry Climax engines released to him by the Cooper Car Company just before the German Grand Prix held in August at the Nürburgring. This engine, on which I hope to write at greater length in the near future, is over 40 lb lighter than the old four cylinder Climax unit, and is said to develop a further 20 bhp. It is still 15 bhp below the reported output of the current Ferrari, but there is little doubt that the power output of the Climax engine will be raised considerably by next year, and could possibly match the 1962 Ferrari figure.

Unfortunately, at the Nürburgring circuit, Brabham went off the road, probably due to not having the correct tyres for the prevailing conditions. Tyre choice is, of course, always a gamble in a long race when conditions are likely to change. Brabham was, however, in the lead on the first lap and the car had shown great promise in practice.

For the Italian Grand Prix at Monza, Moss and the Rob Walker équipe were issued with the second of the V8 engines to be produced, but here both Brabham and Moss experienced cooling troubles in practice. The latter, having a slender chance for the driving championship, elected to drive the 1961 Lotus with the old design FPF four cylinder engine, but Brabham, with no hope whatever in the championship this year, decided to run his Cooper with the new V8 engine until all the coolant was used. The objective being to try and calculate the potential of the car for next year. Brabham managed to hold the four leading Ferraris for nine laps, and then he retired with the expected cooling trouble. On the fifth lap it is significant that less than a second separated the leading Ferrari from Brabham in fifth place. From this we can at least hope that patient development will bring our drivers and chassis manufacturers within striking distance of the Italian cars next year.

Another interesting technical development at Monza was the introduction of a new BRM. This car, which the Rubery Owen Organization had produced in ten months, is without doubt the finest looking Grand Prix car produced for some years. It could be described as a "classic" of rear engine Grand Prix car design. At Monza, it was plagued with various minor troubles, but went very well in practice lapping only 2·5 seconds slower than the fastest of the Ferraris. However, fuel starvation troubles caused the entrants to substitute the older model for the race itself. The engine of the new BRM is also a V8, but no power output figures are available, so comparison with the Climax unit is not possible at this stage.



The V8 rear engine BRM, which made its debut at Monza. It should enhance Britain's chances next season.

Monza was the scene of the terrible accident which involved Von Trips, Clark and many spectators. It is doubly ironic that the accident did not occur on the banked part of the circuit where trouble, if any, was expected by the drivers, and that it occurred after only one season of the new formula, which was introduced originally for safer motor racing. It is difficult to see how any circuit or any formula can be completely free from the danger of cars running into the crowd, although at Monza there was only a slight incline and a wire fence separating the spectators from the circuit. In this country the RAC has insisted on stringent safety measures, which include walls of earth, concrete or sleepers. But there still remains the problem of the airborne car. The light and low cars of today become airborne in many crashes, particularly when a car runs up the back of another at speed, or when a low obstacle or soft earth is hit with the car out of control and sliding sideways. I have seen this happen several times, on one occasion a car travelled some 50 yards at a height of seven or eight feet.

A great deal more research needs to be done on the question of spectator safety, even in this country. Banks should have vertical walls on the circuit side, with declines into ditches down to the base of the wall, this would act as a car trap on any vehicle which was out of control but still on the ground. Also on the outside of any fast corner where spectators are allowed, low walls, soft earth, and similar potential obstacles should be eliminated as far as practicable.

The original 1961 formula 1 called for rubber aircraft type fuel tanks, and one feels that these should be introduced for all racing cars of any type. This was one of the proposed regulations for the new formula that was dropped. When racing cars crash they invariably crack or hole the fuel tank, which again could cause an ugly scene, on what might have been a minor accident.

Perhaps the most interesting development during 1961, and for that matter for many years, has been the introduction of the Ferguson. It is stated that this car incorporates many of the ideas for the Ferguson passenger cars when they are introduced. There is some difficulty in driving a car with so many unconventional features, which readers may recall include four wheel drive, and inboard disc brakes, complete with a perfect distribution of braking effect up to locking point. I am told the car is unusual to drive and it is easy to imagine that normal racing techniques are not possible with a four wheel drive car. Once lined up for a corner to be taken at optimum speed with a four wheel drive car, you are committed to that line. At Oulton Park, Moss drove the car to a most impressive victory—this was only its third appearance. It is unfortunate that he had trouple at the start, and was fifth into the first corner, because one of the advantages of four wheel drive cars should be considerably better acceleration than on a normal vehicle. Nevertheless, he quickly got the car into the lead and remained there, on a very difficult circuit and in conditions that varied between wet and dry. Whether the result would have been the same had he been driving a conventional car is a matter of conjecture. It is sufficient to say that the car stayed the course, finished the race well over half a minute in front of Jack Brabham's Cooper, and also made the fastest lap.

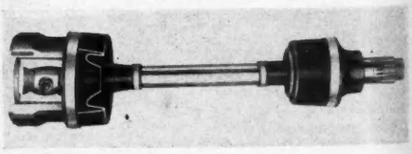
British Built Units for New Italian Car

Lancia of Turin, one of the pioneer motor manufacturers, have placed an order with Hardy Spicer Limited for the supply of universal joints for the front-wheel drive Flavia 1½ litre saloon. This order is worth £300,000 a year and is likely to be increased as production of this, the first front-drive Italian car, rises. The Birfield Group company obtained the order in spite of strong competition from overseas manufacturers and it is encouraging to know that British accessories are being specified increasingly on foreign-built cars. Road springs, drum and disc brakes and engine bearings made in England are among the units being sent to overseas assembly plants.

Four Hardy Spicer constant velocity joints are used in the transmission of the Flavia. They are similar to those used on the Austin Seven and Morris Mini-Minor and the manufacturer claims that no replacements have been needed among the 300,000 already in use on these small cars. Universal joints on a front-drive vehicle have an arduous life as they have to transmit power at constantly varying angles.

The normal pin-type or Cardan joint distorts the uniform rotation of the driving shaft to an irregular jerky motion of the driven shaft. These torsional pulsations are the cause of vibration, noise and will cause rapid wear of bearings, oil seals and splines. The pulsations are especially troublesome in a front-drive system and can lead to road wheel-tremor and inaccurate steering.

The Hardy Spicer joint uses six steel driving balls all transmitting torque simultaneously in either direction to give vibration-free transmission. Constant velocity is achieved by the track geometry which steers the balls and their cage to lie at all times in the plane which bisects the angle between the driving and driven shafts, irrespective of the angle. A maximum deflection of 40° is allowed for.



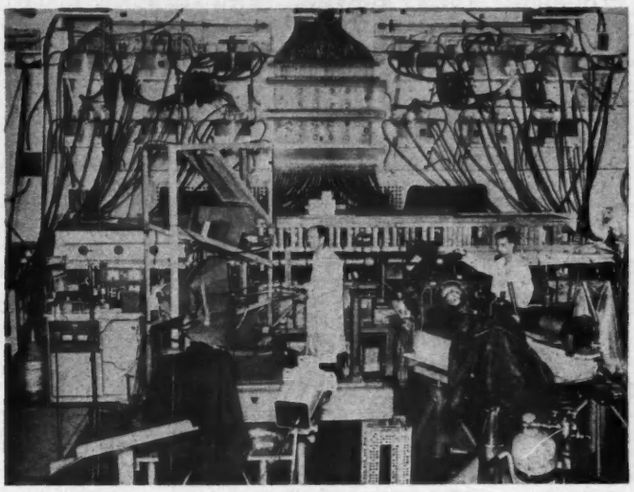
The Hardy Spicer constant velocity joint for the Lancia Flavia is completely weather-sealed.

No separate thrust bearings are required as the joint assembly has considerable end thrust capacity in either direction. The joints used on the Flavia are approximately 3·25 in diameter, which are prepacked with lubricant during assembly and fitted with gaiters so that no maintenance is required.

Plasma Problems Slow the Advance

A collision of American and Russian points of view in recent research enlivened the International Conference on Plasma Physics and Controlled Nuclear Fusion Research held at Salzburg.

By Dr. A. A. Ware, F.P.S., A.R.C.S.
Associated Electrical Industries Limited, Research Laboratory, Aldermaston



The fast compression magnetic mirror experiment at the US Naval Research Laboratory, Washington, DC. Currents up to 20 megamps are passed through a single turn coil generating magnetic fields up to 150,000 gauss in 14 microseconds, causing rapid compression of the plasma, and electron temperatures of 2×10^7 degrees.

THE quest for controlled thermonuclear power has entered a slow plodding stage where advances towards the final goal are being made by many small steps. The initial phase has passed in which many new approaches were being hurriedly tried in the hope of a quick success. At this conference no essentially new approaches were announced; all the experiments reported were carried out with the basic types of devices described at earlier conferences.

The thermonuclear scientists have come to realize that ionized gas (plasma) in a magnetic field has many complex properties. Even when the plasma is uniform and in thermodynamic equilibrium there are no less than nine types of wave motion possible. When the equilibrium and uniformity are disturbed several of the wave motions can become unstable and many other types of instability can occur. Most thermonuclear scientists now believe that they must first discover and understand the laws of this new branch of physics, plasma physics, before they will be able to succeed in producing a thermonuclear reactor.

Advances with Higher Energies

Advances have been made in the various approaches, of course, by extending them to higher energies, by the addition of modifications to improve their performance, and especially by the development of new measurement techniques to determine the properties of the high temperature plasma produced.

The most notable announcement of the conference was essentially a negative one connected with one of the magnetic mirror machines at the Lawrence Radiation Laboratory, Livermore, California; and these same devices were responsible for a heated controversy between American and Russian scientists which enlivened the proceedings. At the Geneva Conference in 1958 the Livermore group reported results for a mirror machine in which a plasma with very high electron temperature (10^8 degrees) but low positive ion temperature was contained for 1,000 microseconds free from detectable instabilities. Since then this apparatus has undergone modification so that high ion energies could be achieved. In October 1960 this group reported that a plasma with ion energies equivalent to 4×10^7 degrees and low electron temperatures (about 10^6 degrees) had been produced and contained for the duration of the magnetic fields, namely 600 microseconds, the evidence for the containment coming from the detection of nuclear reactions throughout this period. These results were impressive and an announcement was made to the press.

Experimental Error

Unfortunately the American physicists on this team had made a mistake. In their paper at Salzburg they reported that subsequent measurements had shown the hot plasma to be contained for only 90 microseconds, one seventh of the original time claimed. At the end of this time the plasma had passed to the wall on one side of the apparatus. The neutrons counted after this time had been produced during the first 90 microseconds; they were slowed down by the water and other hydrogenous materials in the magnetic coils outside the apparatus, and then entered the counters at the later times.

To the Americans present it was doubly disappointing. Not only had they to admit a mistake, but it put them at an initial disadvantage in the heated argument which they subsequently had with the Russians on the stability of plasma in mirror machines. The Russian scientists have worked with three different mirror machines and the results they reported showed that in all three cases the so-called "flute" or "interchange" instability was occurring. (Regions of hot plasma near the centre and regions of cold plasma near the walls with their associated magnetic fields were changing places, rather like thermal convection.) The Russians claimed that all mirror machines must be unstable. Since the original American work was contrary to this claim they freely doubted its accuracy, and they cited the latest American result as an example of the "flute" instability. They wanted to know why the Americans had not published more information on their original experiments, since if true they were very important. The Russian remarks often bordered on rudeness.

In order to allow further time to clarify this question an informal discussion was arranged for one evening. Nearly all the 500 delegates turned up to hear the fun. In the American's favour was the one example of a mirror machine in Nature, namely the Van Allen belts in outer space. Research with rockets has shown that in outer space charged particles are trapped for long periods of time in that part of the earth's magnetic field which has a configuration similar to a magnetic mirror machine. In this case also, the electron temperature is higher than the ion temperature.

Plasma Stabilization

The Americans and Russians did agree that if the plasma in a mirror machine were unstable, there were modifications which could be made to the magnetic field configuration to achieve stability. In fact right at the end of the conference, on the Saturday morning, an unprogrammed Russian paper was read reporting results in a modified mirror machine, in which the magnetic field increased in all directions away from the centre and not just towards the ends. The plasma containment time was about five times longer. One could not help thinking that the Russian contributions to the conference had been well stage-managed.

Most of the other types of devices also were troubled with instabilities in one way or another. The pinch discharge teams (Zeta, Sceptre, etc.) have been giving detailed study to the loss mechanisms from their discharges. Theory and experiment indicate that a convective instability is the main loss mechanism in these devices. One method of stabilizing these instabilities has been to insert a metal conductor down the centre of the discharge tube, so as to change the magnetic field configuration and give the hot plasma an annular shape.

Trends and Discoveries

The most popular type of experiment at present is the fast compression mirror machine ("Thetatron" or "Theta-Pinch") such as is shown in the illustration. "Soon every housewife will have one" was an example of the Khrushchev-type humour of the leading Russian delegate, Artzimovich, who was also responsible for the rude remarks about American mirror machine experiments. In these fast magnetic mirror experiments very large magnetic fields of up to 100,000 gauss are generated in a few microseconds, causing rapid contraction of the discharge plasma to a small volume. Temperatures exceeding 10 million degrees are regularly produced and also high densities, but so far only for very short times. With one or two possible exceptions all these experiments show instabilities.

The new 30 million dollar stellarator (Model C) has just been completed at Princeton University. Preliminary results show the same rapid losses as the smaller machines, but the helical stabilizing windings have yet to be tried.

A new atomic process has been discovered at AWRE, Aldermaston. When a beam of fast neutral atoms is injected into a magnetic field, those in a highly excited electronic state are spontaneously ionized. Such particles need only a strong electric field to ionize them.

In a survey of the experimental work, which Artzimovich was invited to give at the end of the conference, his apt concluding sentence was "Surely it is no more likely that the gates of the thermonuclear Eldorado will open to the first sounds of fusion scientists, than it is that we will enter into Paradise without spending a period in Purgatory first." The theoretical work was surveyed in turn by the leading US theoretician, Marshall Rosenbluth. He thought that controlled thermonuclear power would be achieved in 20 years, provided that man had in the meantime solved the more difficult problem of uncontrolled thermonuclear power.

Strengthening Weak Rocks

Rock mechanics is in its infancy: correlation between laboratory tests and site behaviour is required. Strengthening methods available are grouting, rock bolting and electrochemical induration.

THERE is a crying need for more knowledge about the behaviour of rock under load, particularly *in situ*. Numerous appeals have been made of late for the publication of data obtained during full scale loading tests on rocks; such tests might be made in tunnels or shafts, in open excavations, on the sites of dams or below the foundations of large buildings.

Rock mechanics is a new subject. It now stands in a position similar to that occupied by soil mechanics between the wars. There is a constant demand for measurement of the properties of rocks, both in the laboratory and at site, but more important is the need to relate rock characteristics to rock behaviour *en masse*, and to determine the mechanical properties of the rock under conditions that exist in nature.

The topic is becoming more and more important because, throughout civil engineering, stresses are increasing. In steel, and especially in concrete, design stresses are noticeably higher than they were twenty years ago. Commercial buildings are multi-storey and the foundation loads, usually concentrated at points below the main columns, are heavy. In factories and works, plant and equipment is, generally, getting bigger, heavier and operating at higher speeds than before—with a consequent increase in the loads imposed on the foundations. In irrigation and hydro-electric works, the demand to impound a larger proportion of the run-off, to develop a greater head so as to generate more power, has meant higher dams with greater hydrostatic loads and bigger thrusts against the abutments. In all these cases, the design of the foundation within the rock is just as important, if not more so, than that of the structure itself, if an overall factor of safety is to be obtained.

DATA REQUIRED

The properties that need investigation, either at site or in the laboratory, are:

General state of the rock: permeability, fissuring, jointing, weathering, etc.

Compressive strength, compressibility, and, where possible, the shear and tensile strengths.

Dynamic and static elastic properties, Poisson's ratio, cohesion and angle of internal friction; Mohr's circles for different stress combinations.

Residual stress state (especially for tunnels and other deep underground installations); creep characteristics.

Susceptibility to degradation; and

Measurement of thermal properties of the rock in those instances where underground ventilation will be required or where machinery that involves heat transfer is to be installed.

Most important, however, is that an overall geological appreciation of the site shall be obtained; particularly the location of faults and the inclination of strata with respect to the loading conditions that will ensue; bedding of the rock is particularly important and dip can have a major influence on elasticity. In addition to these natural conditions of the rock mass, the effects of intrusion into the rock, whether by tunnelling, drilling, open excavation or blasting, must be taken into account. Weathering and other alteration processes are important and may be hydrothermal, chemical or physical in character. Local seismic activity should be assessed. And finally consideration must be given to geotechnical effects such as temperature and barometric changes, movements of the pore water, and geothermal gradients.

It is now known that the history of loading within the rock is of great significance and that account must be taken of locked up stresses if the rock is to be treated as integral part of an engineering design. In the case of a concrete-lined pressure tunnel, for example, a knowledge of the residual stresses is required if the lining is to be reliable and economically constructed. Internal stress concentrations in the rock mass give rise to dangerous rock "explosions" or "popping" in the walls of tunnels or other underground structures, particularly in hard sound rock. With smaller internal stresses, difficulties may be experienced with creep of the rock.

In all these cases, lack of homogeneity must be taken into account and every allowance made for stress concentration due to isolated cracks. There appears to be a need for the development of the freeze techniques used in photoelastic investigations that can be applied to determine the stress changes in the rock mass during and on completion of underground works.

TECHNIQUES

There are two principal methods of rock improvement—grouting and rock bolting.

Pressure grouting consists of injecting cementitious slurries to fill the cracks and crevices. Originally the intention was merely to prevent the percolation of ground water, but it is also now used to improve the mass strength and elastic properties of a bed of rock. Gelling of the grout is produced by the chemical reaction between two or more fluids which may be introduced either as a single solution, gelling being delayed by an additive until after injection, or as two separate solutions which do not come into contact until after injection; in this latter case, known as the two-injection process, the second fluid has to be capable of flowing rapidly through ground already impregnated by the first fluid. The process usually involves the formation of a precipitation of silica gel by the chemical reaction between a highly concentrated solution of sodium silica and a strong electrolytic salt solution, such as calcium chloride. This can bring about the permanent solidification of loose granular material or make a highly fissured rock into a continuum.

The salts are introduced into the ground to be treated through perforated injection pipes. Measured volumes of the sodium silicate are pumped into the ground, displacing the ground water; when the mass to be treated has been filled with the first solution, the second, usually highly concentrated calcium chloride, is introduced, a base exchange process occurs and a permanent gel is formed. The advantages of the method are that it can be carried through almost irrespective of the chemical nature of the rock being treated; the treated area can be closely controlled; and the gel is virtually inert and will not attack either concrete or steel. Care must be taken under some conditions to see that the head on the injected solutions is not so high as to cause some worsening of the cracking in a bad patch of rock.

The extent to which grouting may be used varies enormously. At the lower end a typical example might be the formation of a solid block in granular soil below the foundation for a building—say a treated volume of 8ft wide by 15 ft deep by the length of the wall, perhaps 40 ft. Somewhat larger is the case of a tunnel driven through poor water-bearing soil where the treated cross-section might be a circle of 40 or 50 ft diameter running for the length of the tunnel. At Kariba, where a cement grout was used, over 7,000 grout holes were drilled, and 7,000 tons of cement and 1,700 tons of sand injected in the successful effort to seal the power house, gate shafts and surge chambers, all of which lie within the rock abutment and below final reservoir level.

Rock bolts originated in coal mines to increase the safety of gallery roofs by pinning loose strata into place. By using the bolts in conjunction with a light steel mesh, they have been proved an excellent method of strengthening highly fissured and closely jointed rock. The bolts may be anything from 3 or 4 ft long up to 15 ft or more in length, but all of them have some means of expanding the leading end so that they can be firmly fixed into the rock; but the technique of their use is not solely dependent on finding a backing of sound rock to which the loose face is fixed, but rather the joining together of separate beds so that they behave together in a composite action.

Some applications where rock bolts have been successfully employed include:—

Pinning and supporting large blocks and slabs.

Suspension of rock masses at intersecting faults.

Keying of large blocks to prevent slopes being undermined.

Confining and reinforcing local gouge zones to drive potential failure planes to a greater depth.

Reinforcing rock ribs to prevent expansion and failure.

Tying together and reinforcing laminated rock formations to prevent shear failures.

As stress control bolts in high faces to prevent bulging due to rock load and blasting.

There appears to be no reason why rock bolting and grouting should not be used as complementary treatments for the same rock mass if conditions warrant it. An extension of the rock bolt technique is the use of pre-stressing cables to tie back large masses of rock to a hillside, the alignment of the cable coinciding with the expected line of action of forces to be imposed on the rock by construction works. The same basic principle is to be found in the concept of prestressed concrete dams, such as at Allt-na-Lairige in Scotland, or in the heightening of dams as is currently being carried out at Falmouth in the west of England.

ELECTROCHEMICAL METHODS

A third method of strengthening rocks, but which has not been so widely used as grouting and rock bolting, is electrochemical induration. For this third technique, a direct current at between 300 and 500 volts is passed through the clay or sand; marked changes are induced in the chemical and physical properties of the rock, making them considerably stronger.

The early work using electrochemical methods was all concerned with clays. It has been known for a long time that the passage of a direct current through a clay sample causes a movement of both the liquid and solid particles—electro-osmosis and electro-phoresis. The strengthening of the clay was at first attributed to four factors: (*a*) changes in the electrical charge on the clay particles by exchange of cations in solution—aluminium anodes were used and the aluminium displaced calcium with beneficial results; (*b*) the formation of aluminium compounds, possibly aluminates; (*c*) dehydration of the clay; and (*d*) structure producing processes taking place with the passage of the current. In addition it has been suggested that, as the period of passing current continues, the electrical resistance of the clay changes, in some way causing a hardening of the clay, and that the electrolysis effects occurring, particularly the concentration of hydrogen at the cathode, and of oxygen and chlorine at the anode, are also signs of chemical changes that indicate a stiffening of the material.

The volume of published work available on this technique is small but a translation of a Russian paper has recently appeared: *Electrochemical Induration of Weak Rocks*, by Titkov, Korzhuev, Smolyaninov, Nikishin and Neretina, published in the United States by Consultants Bureau of New York ($12·50). Much of this Russian work has been concerned with the strengthening of the clay strata drilled for oil shafts, but there seems no reason why the method should not find a wider application than this—for example, the strengthening of clay (or fine sand) embankments or of sub-grades below road formations.

Illumination of Motor Road Tunnels

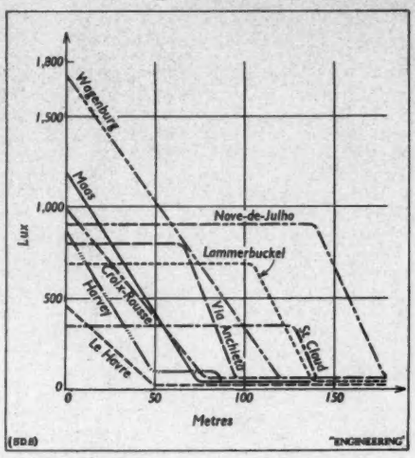
A particular aspect of the problem of illuminating roads is that of lighting the approaches and interior of tunnels used by fast travelling road vehicles. Good lighting is obviously necessary if traffic speeds are not to be restricted and if serious accidents and driver frustration are to be avoided.

This tunnel problem is discussed in an article entitled "Moderne Beleuchtungsanlagen fur Schnellstrassentunnel," by Herr F. Tomek writing in *WSW Technische Berichte* (Austria), No. 1, 1961, pp. 3 to 13 (in German). The author sets out to find a system of illumination giving maximum safety at minimum cost.

There are three main aspects of the problem that receive detailed consideration in the article including:

(1) Speed of adjustment of a normal driver's eyes to changes in illumination from high intensity outside the tunnel to the safe minimum of intensity inside.
(2) Suppression of reflection in the approaches to the tunnel and full utilization of reflection inside.
(3) Economizing of power by making maximum use of available daylight by shaping the tunnel entrances and, with the assistance of photocells, automatically reducing artificial illumination when there is an increase in natural lighting entering from the outside of the tunnel.

Accompanying the article are a number of photographs which show the foreground and interior layout of existing tunnels and numerous graphs, of which one is reproduced here. It shows how the minimum lighting condition is reached in a number of well-known tunnels; the light unit used is the lux.



Fall-off of lighting intensity in nine tunnels.

British Railways' New Research Buildings

The British Transport Commission have placed a contract with William Moss and Sons Limited, Loughborough, for the construction of the buildings for British Railways' new £1¼ million engineering laboratories and research department headquarters in London Road, Derby. Work is about to begin and will take approximately two years to complete.

The project is part of a comprehensive scheme to reorganize and expand the railways' research department which began with the completion last year of new chemical laboratories at Muswell Hill, London. Under the scheme, the engineering, vehicle and track-testing, metallurgy, and physics divisions will be combined and housed in the new buildings at Derby, which will also become the headquarters of British Railways' director of research, whose present office is in London. The new group of buildings has been designed by the Commission's architect, F. F. C. Curtis, Dr. Ing., A.R.I.B.A.

The largest buildings in the group will be a flat-roofed five-storey administration block housing scientists' study rooms, a library and offices, and, at the west end, a large equipment test hall 200 ft square. The whole group of buildings will have a total floor area of about 100,000 sq. ft and will occupy 85,000 sq. ft of ground.

The administration block will be constructed of reinforced concrete framing with window glazing units set between the concrete frames. Beneath the window sills the sides of the building will be faced with opaque white vitreous panels. The concrete frames will be faced with black aggregate.

The main test hall at the far end of the site, which will be about 40 ft in height at the eaves, will have blue-grey brick walls up to 19 ft above ground level. Above this, the rest of the building, including the flat roof with seven projecting north lights, will be a steel framed structure clad completely in glass to give the maximum natural lighting.

The entrance to the group of buildings will be protected by a concrete awning set in the centre of the front of the administration block. Opposite the entrance will be a surfaced car park. At the rear of this block there will be a paved and landscaped quadrangle enclosed on the other three sides by single-storey laboratories of the same construction and with similar black and white facings. The laboratory wings to the left and right of the quadrangle will extend forward alongside the ends of the administration block so that the five-storey building lies between the ends of the wings.

On the far side of the laboratory building (and across the quadrangle from the rear of the administration block) an extension will connect the laboratories with the test hall. As well as linking the test hall with the rest of the group the extension will also accommodate an instrumentation store, staff amenities, and, beneath it, a boiler house. The boiler house chimney will be clad with aluminium to reduce maintenance costs.

Within the laboratory sections the layout has been designed on the basis of a 6 ft module. The main services—electricity, gas, water, and heating—will be conducted in "walk-through" ducts beneath the laboratories to give service engineers easy access when changes in the supply are needed.

This section will contain a wide variety of laboratories equipped for studies of physics, heat, acoustics, light, metallurgy, and metallography. There will also be instrumentation and photographic laboratories, a drawing office, and special rooms for computers. The large test hall will include a heavy dynamic fatigue testing installation for experiments with bridge girders, underframes and concrete units, a static 250 ton compression machine for testing carriage underframes, and vehicle inspection pits. It will also contain a special area for testing small components, a stores room and a workshop.

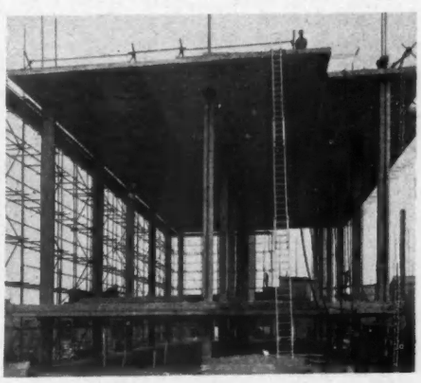
Factory Floors Jacked Up Into Position Reduces Cost

During the next few weeks the first, second and third floors of a large four-storey warehouse and office block, now being erected for the Laboratory Chemicals Division of the British Drug Houses Limited at Poole, Dorset, by John Laing Construction Limited, are to be raised from the ground hydraulically by the lift slab method of construction. Work on the new building, which is 340 ft long and over 100 ft wide, began in March this year as the third and final stage in a £1 million development programme by BDH and is due for completion by mid-1962.

The building has been divided into four sections, each requiring up to 24 precast concrete columns, 16 in square and 38½ ft high. Reinforced concrete roof and floor slabs, 9 in and 10 in thick, with a separating medium of resin dissolved in a volatile spirit, have been cast at ground level round the columns and are being raised at the rate of some 8 ft an hour. Each section is to be completely lifted and connected within one week. British Lift Slab Limited are carrying out the lifting operation. Each hydraulic jack has a maximum working capacity of 70 tons and the equipment is so connected that all units work together; it is possible to break the circuits and make an individual adjustment to a particular jack.

Jacks are mounted on the top of the columns with rods reaching down to the slabs at ground level. A reciprocating action causes the rods to be raised and passed through the body of the jacks, thus raising the top slab, and subsequently the lower slabs, to their final positions. The slabs are connected to the columns by a combined shear block and wedge. Inserts are provided in the reinforced concrete columns at each floor level, to which the wedges and shear blocks are attached, the collar of each slab resting on the wedge and shear blocks. The whole connection is later encased to provide full protection from fire.

The architect for the project is Sydney Greenwood, A.R.I.B.A., and the office of the chief civil engineer of John Laing and Son Limited has been responsible for the civil, mechanical and electrical design.



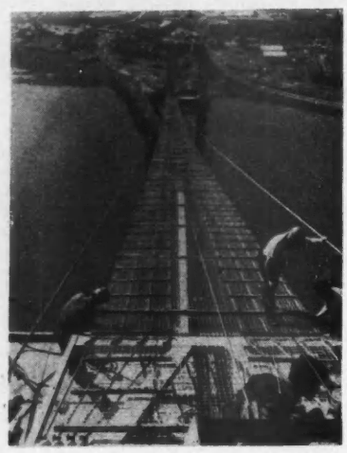
After casting at ground level the complete floor is raised into position by jacks on the top of the columns. This method of construction considerably reduces initial costs.

Footbridge over the Forth

Twin temporary footwalks forming a total span of 13,000 ft are being erected on the Forth Road Bridge during its construction to enable the main cables to be spun and suspenders for the deck sections to be fitted (ENGNG., 31 March, 1961, p. 453).

The floor panels are 9 ft 2 in wide by 10 ft long, and 10 ft 6 in long of 2 in by 3 in centre to centre mesh with 6 swg wires at 2 in centres and 4 swg wires at 3 in centres. The panels have been specially produced by the Weldmesh Department of the BRC Engineering Company of Stafford. The 3 ft 6 in side panels are made up of 6 in by 3 in Weldmesh by 10 swg galvanised wire. These are secured to the floor panels by means of a series of 9 in long helicals.

Each footwalk is supported by eight multi-strand cables 1 in in diameter, each cable being made up of 19 separate 0·16 in diameter wires. The side panels are secured to hand ropes above



the footwalk, and seven cross bridges of cross braced tubular steel section connect the footwalks toge he·.

Since some stretches of the footwalk have inclines of 23 degrees, to assist those working on the main cables timber stringers will be secured to the mesh at 1 ft 6 in intervals on the steeper sections and up to 5 ft intervals elsewhere. The timber stringers will also prevent friction between the wires forming the main cables and the footwalk. The illustration shows the floor panels in position and the horizontal stringers. The placing of the side panels will follow as the next operation.

The Forth Road Bridge is being built by the ACD Bridge Company, a consortium formed by Sir William Arrol and Company Limited, the Cleveland Bridge and Engineering Company Limited, and Dorman Long (Bridge and Engineering) Limited. The consulting engineers are Mott, Hay and Anderson, in association with Freeman, Fox and Partners.

Maximent Floors Resist Chemicals

A new product has been developed by the surface coatings division of Burk, Boulton and Haywood Limited, Belvedere, Kent, with the object of providing industrial and commercial premises with a flooring material that will withstand those hazards which have hitherto made other surfaces so impermanent and costly. Its ease of application, relatively low cost, and attractive range of twelve colours, including black and white, render the compound equally suitable for use in domestic premises—marbling effects can also be obtained with little additional cost and trouble.

Maximent, as the new material is named, is a liquid dressing applied over a prepared base and has the advantage of hardening rapidly. The base should preferably consist of a 3:1 sand/cement screed, properly laid and dried. This has to be followed by the brushing on of a special primer, which is ready for coating in two to four hours. Maximent is then poured on and spread over the area to be covered.

Being of a creamy consistency, the compound will level itself before starting to set, a process which takes approximately four hours. Complete curing takes between eight and twelve hours, so that floors treated one day can be brought into full use on the next. The material is stated to be waterproof, fire resistant and able to withstand heat up to 250°F.

Among the hazards which Maximent has been designed to overcome are dust, chemical attack and impact from heavy weights. The compound is bound by chemical reaction throughout its whole mass, eliminates dusting-up, and is consequently very suitable for use in factories and laboratories where delicate instruments are being either produced or used as part of the facilities.

Maximent offers much greater resistance to substances used in many industrial processes than concrete, cement and plastic flooring compounds. It is impervious to many substances, including hot fat, wines and spirits, soaps, dilute sulphuric acid and diesel oil. When laid normally, and treated with Maximent non-slip polish, the compound provides a safe walking surface.

New Football Club Stand

A new stand on the north side of the football field at Sheffield Wednesday's ground in Hillsborough has been built to seat 10,000 spectators in a length of 362 ft. There are 48 rows of tip-up seats with a rise from front to back of the stand of 50 ft 8 in. Since there are no columns between the spectators and the field, every seat has an unobstructed view.

The height of the underside of the roof is 60 ft and the clear overhang is 124 ft. The roof covering is provided by aluminium sheets which are supported by steel lattice girders cantilevered from the back of the structure and projecting 16 ft beyond the front row of seats to provide protection from driving rain. The terraces supporting the seats are constructed of 3 miles of prestressed, precast concrete units resting on a reinforced concrete substructure, except at the upper part of the stand where the steel roof girders are turned back under the stand to support both the roof and seating units; thus giving anchorage for the cantilevers.

There are two entrances to the terraces; one at road level and the other 12 ft above the road, communicating with an elevated walkway running the full length of the stand with large easy-graded reinforced concrete spiral ramps at both ends of the stand. The ramps are sufficiently strong to allow light vehicular traffic to drive up to the higher level refreshment bars.

Construction of the new stand commenced last summer and is on the site of an old grandstand built in 1900. The main framework supporting the terraces and the back row of columns supporting the steel cantilever roof were all of precast concrete sections made by the contractors on site.

The main contractors were George Longden and Son Limited of Sheffield, and the constructional steelwork was fabricated and erected by T. W. Ward Limited of Sheffield.

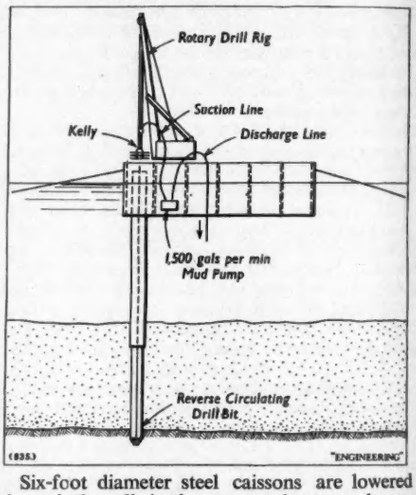
New Additive to Concrete Improves Workability

A new liquid additive is being marketed under the name of "Flocrete." It has a main base derivative of organic hydroxy-carboxylic acid. It contains no calcium chloride and does not retain air, since the manufacturers feel this is not important in a country with moderate temperatures. The additive allows a substantial reduction in the water content during mixing and in addition plasticizes the concrete to a uniform quality. Before the additive was placed on the market, independent tests showed that the design strength of a structure could be reached using a cement content up to 20 per cent less than the specified amount. Also the compressive strength of hardened concrete may be increased up to 25 per cent, and the bond strength in conjunction with steel up to 20 per cent.

The plasticizer is designed as an aid to mass and reinforced concrete work and increases workability up to 150 per cent, thereby allowing larger pours and easier finishing. The controlled workability together with water reduction give a wider choice of mixes and materials. The product is made by Quickset Water Sealers Limited.

Floating Box Footing for Bridge

A time saving technique for building deep water bridge pier footings was developed during the construction of a new bridge in Northern California. The method, an extension of the Mulberry harbour of the last war, involves floating reinforced concrete boxes (44 ft × 86 ft × 25 ft). The boxes are cast on dry land, launched on to the water, and towed to the bridge by tugs and anchored into place.



Six-foot diameter steel caissons are lowered through the cells in the concrete boxes to the sea bottom. When filled with concrete the caissons provide legs to support the box footing. The boxes are eventually filled with concrete to serve as the foundations for the concrete bridge piers.

The illustration shows the box anchored in place while a drill rig working through an 80 in diameter temporary casing, drills through the overburden into bedrock. Subsequently, the permanent 72 in caissons are placed and filled with reinforced concrete.

Proposed Chowilla Dam

Chowilla, in South Australia, is the proposed site for the country's largest water storage dam, which will be at the junction of three states. The dam will cost £A13 million, and will take its water from the Murray River guaranteeing South Australia against shortages of water for irrigation and domestic use. The site is 12 miles downstream from the New South Wales border, and its construction would cause water from the river to back up into New South Wales, covering an area estimated at 400 square miles, with a capacity of nearly five million acre feet and a surface area 50 miles long and seven miles wide. The Premier of South Australia, Sir Thomas Playford, is seeking a conference with the Premiers of Victoria and New South Wales to consider the construction of the dam.

Companies

Staff Grouping an Aid to Efficiency

RECONSTRUCTION at the Phoenix Works of R. B. PULLIN AND COMPANY LIMITED has now been carried a stage further by the completion of an office block, which was brought into use last month. The first section of the firm's development plan took place some five years ago when another building, to accommodate laboratories and assembly departments, was erected at the rear of the factory, in the Great West Road London.

In the new block, pleasant working conditions have been a main consideration. Where, previously, it had been necessary to disperse certain administrative sections of the staff throughout the Phoenix Works, the completion of this office building has enabled these groups of staff to be brought together; an arrangement which the management have desired to bring about for some time and which will make for improved efficiency.

Double glazing has been provided in order to reduce traffic noises from the Great West Road and cork has been used for all office floors in a further endeavour to minimize this nuisance. As will be seen from the accompanying illustration, the new building is linked with the existing front block and the two units together provide an attractive frontage to the Great West Road.

R. B. Pullin began operations in 1932 not far from the site of their present Phoenix Works and have built up manufacturing interests in a wide field of electronic, electrical, mechanical and optical equipment. Six subsidiary companies are located in the London area and in Birmingham.

Pressed Steel's New Training Centre

A firm that believes in training apprentices (and other grades) comprehensively is PRESSED STEEL COMPANY LIMITED, who have now built a new centre at Cowley. It was officially opened by Mr. W. J. Carron, president of the Amalgamated Engineering Union on 20 September.

The centre will provide facilities for the study and practice of pattern making (and model making); sheel metal work; machining; welding and fitting. There are also two drawing offices, one for the ordinary course, and one for advanced work applicable to those who are making drawing their goal. The apprentices finish their training in the shops of the company according to their bent.

Provision is made for lectures on trade union practice and responsibilities which will be organized by Oxford Universities Delegacy in Extra-Mural Studies. This is believed to be the first time such courses have been arranged in the motor industry.

The company's interests are diversified now in four main fields. In the domestic market with refrigerators; in the motor industry with car bodies (and not all for the mass-produced models); in railways with wagons and rolling stock; and now in the aircraft industry with the recent acquisition of the Beagle Company. As a result, there is a wide choice for apprentices within the company itself.

Not only apprentices are catered for however. There are courses in foremanship, supervisory and superintendent development, and a two-year full-time course for graduate recruits from the universities. There is even one room set aside for shorthand and typing courses, as the company intend to be self-sufficient in all departments.

Modern Style and High Quality

Pressed Steel's building is constructed in what the chairman described as the best modern tradition, since the company believe firmly in quality of the highest order. In addition to those persons actually employed at Cowley, it is intended to provide higher training for employees from the remainder of the company's works, at Swindon, Paisley and Swansea.

Plans are afoot for a hostel to provide accommodation. At any one time, the company has about 1,000 under training, including those at the centres at the other factories and, since 1958, 50 management trainees, 400 supervisors and 1,000 craft and student apprentices have passed through the various courses.

The main part of the building is three stories high, but the ground level is left open of necessity as it provides the only access to a development site in the rear. The administrative block, in which the drawing offices are situated, extends upwards for another two stories.

The structure is entirely in reinforced concrete; thermoplastic tiles are used generally for the floors, except in the craft school and gymnasium where there are wood blocks. Acoustic tile ceilings are fitted throughout. Heating is by accelerated-flow low-pressure hot water with continuous "Vectair" radiators below the window sills. This system permits freedom of internal layout and the movement of internal partitioning as desired. Fluorescent lighting is used in all departments.

A Finger on the Maritime Pulse

Burmeister and Wain, the famous Danish builders of marine diesel engines have strengthened their ties with this country by the formation of a new subsidiary company known as BURMEISTER AND WAIN (GREAT BRITAIN) LIMITED.

With offices in Leadenhall Street, in the heart of London's shipping world, B. and W. feel that they will be better able, through their new branch firm, to keep their fingers on the pulse of British maritime activities and, indeed, on those of the whole world, because as Mr. Niels Munck, managing director of Burmeister and Wain, expressed it, they still regard London as "the most important shipping centre in the world."

The new company will represent their principals in all their activities in Great Britain, and provide a liaison with their sole British licensees, HARLAND AND WOLFF LIMITED and Harland's sub-licensees, JOHN G. KINCAID AND COMPANY LIMITED. This arrangement will further facilitate the cooperation and exchange of information which has helped in the development of their marine diesel engines over the last fifty years.

Mr. Munck, in opening the new offices, said that, with the possible British entry into the Common Market and with Denmark following suit, the best conditions were present for a continuation and intensification of the cooperation which had existed through half a century between British shipbuilding circles and B. and W.

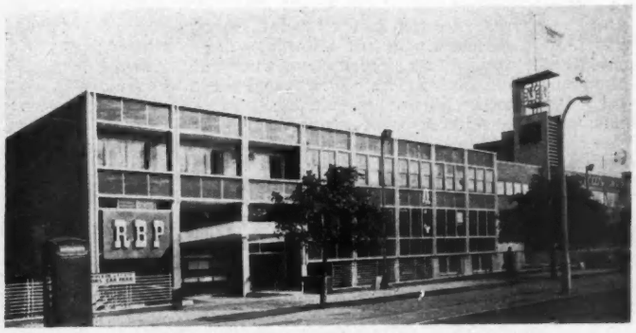
Exports Need Real Incentives

Pleas for the granting of government incentives to manufacturers to encourage them to boost their exports have currently been put forward by a number of company chairmen.

One advocate of such action is Mr. John V. Sheffield, chairman of HORSELEY BRIDGE AND THOMAS PIGGOTT LIMITED, who points out in his annual statement to his firm's shareholders that he cannot, at the moment, see grounds for any considerable improvement in the trades covered by the company.

He feels that the Budget and the measures recently taken by the Chancellor of the Exchequer to correct the country's economy, though necessary in the short term, can only add to the already high operating costs of industry. As happened four years ago, the restrictions on credit and the high bank rate are bound to lead to the cancellation or postponement of projects in which the company's trades would have participated. In the economic measures already taken, he cannot find any encouragement or assistance to greater production or an expansion of exports.

Last year Mr. Sheffield strongly advocated the positive use of incentives to encourage a greater volume of exports. He is not at all convinced by arguments that any fiscal relief will automatically result in a competitive conflict for such allowances. The Government must grasp the nettle now and, in addition to continual exhortations, give encouragement in a very positive way to industrialists so that they may direct their activities with a bias towards exporting.



R. B. Pullin have extended their works on the Great West Road.

A Tax on Turnover?

Many suggestions have appeared in the press and elsewhere which, Mr. Sheffield considers, are worthy of serious consideration. Indeed, some of these are already in use by foreign competitors.

The abolition of the company profits tax in favour of a turnover tax which exempts that proportion of a firm's turnover that is for export, seems, he feels, to be an obvious choice. Contentions that such an arrangement would be unfair to organizations making components for finished articles and, according, not eligible for the rebate, he regards as nonsense. The sale of his firm's goods abroad is the vital concern. Once a sale is made, production and delivery will follow, provided the export incentive is available.

He sees the immediate future of Horseley Bridge against a background of rising costs and finer profit margins, because the volume of available work is likely to diminish. Costs saved by greater efficiency are being offset by the usual annual demands for higher wages and by other increases completely beyond the firm's control.

It was mentioned by Mr. Sheffield last year that general trade conditions were having a more serious effect upon their subsidiary firm MECHANS, LIMITED than on Horseley Bridge and that there would have to be an unprofitable period before results began to appear from the reorganization of these works and the company's association with the Union Tank Car Company, of Chicago.

The main reason for this position was the fact that the trades which Mechans traditionally supplied—principally oil and shipbuilding—had been obliged to curtail their purchases because of the recession. This state of affairs continued during the twelve months ended 31 March last and the works were only able to operate very much below capacity, in spite of considerable reorganization. Price cutting in the conventional platework trade continued unabated.

Consequently, for the first time since they joined the group, Mechans made a net loss, which amounted to just over £80,000. Since the date of last year's accounts, 49 per cent of the capital of Mechans has been sold to the Union Tank Car Company.

Introducing Flich

Another successful year is reported for the GEORGE COHEN 600 GROUP'S contractor's plant hire fleet, which is constantly being reinforced by the introduction of machinery of up-to-the-minute types.

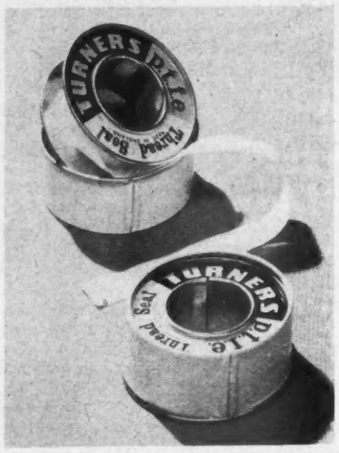
This process is in accordance with the group's consistent policy of plant renewal. The very satisfactory earnings of the department are regarded by the group as being largely attributable to this policy.

An innovation for George Cohen's has been the launching of a scheme for Fork Lift truck Industrial long-term Contract Hire, which, for the sake of brevity and ease of reference, the group have named FLICH. The new service has been welcomed and successful.

XUM

Pipe Thread Sealing Tape

A recent addition to the range of polytetrafluoroethylene (ptfe) products manufactured by Turner Brothers Asbestos Co., is a pipe thread sealing tape. This unsintered tape is supplied as a continuous ribbon ½ in wide on handy metal dispensers in lengths of 20 ft, 30 ft, or 40 ft, and is used for sealing threaded pipe joints at a rate never possible with previous materials, say



the makers. Breaking of the connection is easily accomplished, even after a long period of time.

The plasticity of the material is said to ensure that it conforms exactly to the contours of the thread, resulting in a perfect seal against pressures of many thousands of lb per sq. in. It is also unaffected by temperatures ranging from − 100° C to + 300° C, is chemically inert and will not cause contamination of the liquid being handled. In addition it is impervious to water, steam and most corrosive liquids and gases, and is unaffected by ageing or weathering. For more details get leaflet, Ref. No. SA.12, available on request.

Turner Brothers Asbestos Company Limited, P.O. Box 40, Rochdale.

Polyurethane Pitch Coating

Pervon is a new addition to the Adcora range of anti-corrosive coatings made by E. and F. Richardson Limited. Generically, it is a polyurethane pitch coating and is, so far as the manufacturers are aware, unique in this country. They claim its range of usefulness far surpasses that of epoxy pitch coatings or indeed, most straight epoxy products.

The following statements of properties are made by Richardsons: Adcora Pervon cures rapidly at all temperatures, even those below freezing point. It is unaffected by high humidity during the curing period, which at temperatures found within this country is never longer than four days.

It can be applied effectively both to blast cleaned metallic surfaces and to those prepared by less thorough methods. For continuous immersion however, blast cleaning and dry film thickness of 10 to 15 mils is recommended, whereas in all other types of service (Classes II, III and IV) blast cleaning is not an essential prerequisite, but the use of a primer is desirable. This primer is a metallic lead pigmented polyurethane based product.

Ferrous surfaces protected with a 10 mil coating emerge unscathed and indistinguishable from their original appearance after immersion for six months in 20 per cent nitric or chromic acid. Pervon is equally unaffected by aliphatic or aromatic solvents or fatty acids, even at temperatures as high as 80° C, whilst its alkali resistance is good. Ammonia, acetic acid or 25 per cent hydrogen peroxide have no effect even after prolonged immersion.

After 40 days' immersion in distilled water, Adcora Pervon shows a water uptake as a percentage of the dry film weight of less than 1 per cent. The appearance, cohesive and adhesive strength is unaffected by boiling distilled water.

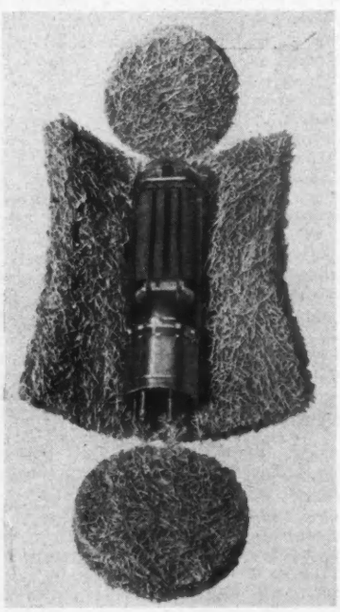
E. and F. Richardson Limited, Buckingham.

Cushioning Material for Packing

Lignatex is a new cushioning material consisting of selected curled strands of seasoned timber bonded with a formulation based on latex. The makers say that the dimension of the strands (1·5 mm by 0·15 mm), the species of wood (spruce), the type of wood shredding machine to give a curly cut as well as the formula of the bonding agent have produced an excellent cushioning material at an economic price.

The material is supplied in sheets 3 ft by 6 ft, 1 in and 2 in thick. For the moment it is available in a nominal density of 3 lb per cu. ft only, but tests show that this is more than adequate to protect a wide range of goods. Lignatex can also be supplied in pieces cut to size as well as fabricated by means of die-cutting, sawing, gluing, etc.

An economic form of fabrication consists of 3 in wide strips glued to ⅛ in hardboard as transit protection for many types of machinery. In one particular case, say the makers, a saving of about 50 per cent of the cost of packing rotary printing machines has been achieved by replacing a large and cumbersome wood-wool mould and



heavy wooden case by five Lignatex/hardboard fabricated pads and a much smaller and lighter wooden case. Small pieces glued on to a scored and slotted piece of corrugated board to form a corner provide an excellent form of cushioned suspension for rectangular items.

Lignatex is uniform in density, dry and free from dust. It is flexible and resilient. The pH value is 7 and according to PATRA tests the sulphate content is 0·014 per cent and chloride 0·045 per cent, which makes it practically free of silver staining agents. Both dynamic and static cushioning tests indicate a favourable performance in comparison with materials like rubberized hair, which are approximately three times dearer.

A. Latter and Company Limited, 43 South End, Croydon, Surrey.

Simple Phosphating Process

The Paints Division of ICI has developed and introduced "Kephos," a non-aqueous phosphating process which they claim dispenses with rinsing and tank-heating, forms no sludge in the processing tank and produces a sealed phosphate coating. The coating enhances paint adhesion and resistance to rust creep in the same way as conventionally produced zinc or iron phosphate coatings. The improvement in the corrosion resistance of paint systems is quite outstanding, say ICI, and the possibility of work being contaminated by waterborne impurities is eliminated.

Kephos contains a sealer which is sufficiently corrosion resistant to protect work during transport or during temporary exterior storage for up to a week, or indoor storage up to six months. Under normal production conditions, work can be welded through the film. This enables items to be treated before fabrication, so that shrouded areas such as interior box sections receive some protection.

The application is not confined to dipping. It may be applied by brush (as in the illustration), roller, spray or flow-coating, the most suitable method depending entirely on the characteristics and number of the articles to be treated.

The method can be used to supplement existing phosphating facilities when an article is too large for the plant or an abnormal volume of work requires processing. For regular use, its higher chemical cost is said to be offset by the compactness and simplicity of plant requirements and the saving in heating and plant maintenance costs, particularly for the manufacturer of a small volume of high quality production. The recommended system is to degrease all work on arrival and apply Kephos before it is put in store; it is thus simultaneously protected and phosphated during storage and subsequent assembly, requiring only the removal of surface dirt to prepare it for painting. Patents are pending for the process.

High and low flash versions of Kephos are available; the first is suitable for all methods of application, drying in about 15 minutes in a warm shop. The time may be reduced by forced drying at 250° F at which temperature only 3 minutes are required. The solvents used in the low flash version make it liable to the Petroleum Regulations; it is unsuitable for dip tank operation. The air drying time is 5 to 10 minutes in a warm shop.

When applied to clean steel the solution dries to give a coating weight of 250 to 350 mgm per sq. ft according to figures quoted by the makers. The phosphate coating forms during drying and no further treatment is required. Painting can be carried out as soon as the solvents have flashed off.

Imperial Chemical Industries Limited, Millbank, London SW1.

Bonding Aluminium to Rubber

According to the Reynolds Metal Company, aluminium sheet and foil now can be permanently vulcanized onto rubber, yielding a material combining the surface toughness, corrosion resistance and insulative values of aluminium with the flexibility of rubber. The process, which has been proved feasible through commercial application, is made possible by a special aluminium coating developed by the packaging research division, Mr. Reynolds said.

Projected applications for the aluminium-vulcanized rubber include aluminium tyre cords for longer wear, flexible aluminium-covered pipe and tubing, tenting and tarpaulins.

Reynolds apply the coating to the metal and ship it to customers in roll form. When the rubber is vulcanized, the aluminium becomes an integral part, as difficult to remove as the tread on an automobile tyre. The exposed aluminium surface can be attractively decorated with colour, printing, or embossing.

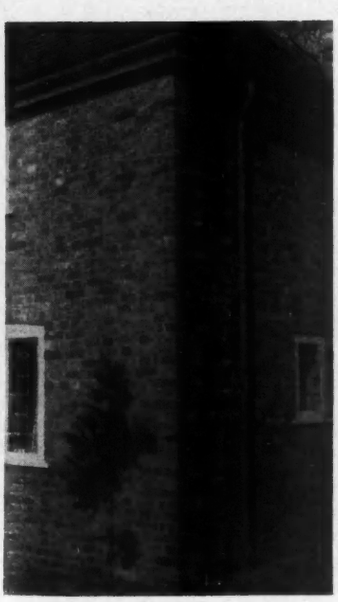
The new process has received its initial application in a household stove and counter mat manufactured by Rubbermaid Incorporated, Wooster, Ohio, for incorporation in its national housewares line. The mat's aluminium surface dissipates heat from the hottest pots and pans, thus protecting ranges, counter tops and tables.
Reynolds Metals Company, Richmond 18, Virginia USA.

Pvc Sheet and Pipe

News from the UAM Group of Companies is of the production of Aspect pvc sheeting and of Aspect rainwater goods. The sheeting is to be made by Allied Structural Plastics Limited who have already been producing pvc pressure pipe for some months.

The flat sheeting is to be made in widths up to 56 in and corrugated sheet, to match 3 in and 6 in asbestos-cement sheet, in widths of 30 and 42½ in. Both flat and corrugated sheets are available in lengths from 4 ft to 10 ft, in 6 in increments. The sheet can also be supplied 56 in wide in rolls up to 30 ft long, transverse corrugated to the same profiles. Standard thickness is $\frac{1}{16}$ in and the weight per sq. ft is approximately 7 oz. All types of sheet are made in a range of four colours, or clear.

The Aspect rainwater goods introduced by the same company are made to give a complete system for pitched and flat roofs and for balcony drainage. (See illustration.) All units have been designed, say the company, to give a clean round line and a neat appearance. Gutters are 4 in half-round and are made in 6 and 12 ft lengths. They are a snap fit in the support brackets. Joints between lengths of gutter are made at the brackets which are supplied with a neoprene sealing strip already fixed; no cement or caulking compound is therefore needed. The gutter brackets are made in three types for fixing direct to a facia board or with top or side fittings for attachment to rafters where there is no facia board on the house.



The downpipes are 2½ in diameter and fixed at 6 ft centres by holders which drop into a tapered fixing bracket screwed to the wall. The system is light and is said to be easily installed by comparatively unskilled labour. The standard colour is a medium blue-grey with a semi-gloss finish, say the firm, and add that black components will be available in January. Apart from the gutters and downpipes mentioned, the system includes headers, bends, angles and couplings so that any normal configuration of roof can be followed. Details of all the components are given in data sheet In6 available from the UAM Group Information Service at Tolpits, Watford, Hertfordshire.
Allied Structural Plastics Limited, Watford and Dunstable, Hertfordshire.

Fire Retardant Slurry

The properties of bentonite as a fire retardant have been brought to the fore as a result of the recent forest fires in Western Canada and Newfoundland. Large quantities of bentonite slurry were dropped by helicopters and air tankers to form a retardant belt around the burning areas.

Bentonite is a fine clay, occurring in many parts of the world, and widely used in the foundry, civil engineering, oil and animal foodstuffs industries. It is therefore readily available, and comparatively cheap. Bentonite, when mixed with water, will absorb up to six times its dry weight in water and expand 12 to 15 times its original dry volume. Its value as a fire retardant lies principally in this unusual ability. When vegetation threatened by fire is treated with bentonite slurry, the water in the slurry and in the vegetation itself must be driven off as water vapour before the fuel can be heated to its ignition temperature. If the heat energy of an advancing fire front is insufficient to do this, the fire's spread will be stopped. The moist coating will remain effective for up to two or three hours under severe American summer drying conditions.

The slurry has been found to penetrate the vegetative canopy satisfactorily, and to coat different types of growth well. It is non-toxic to animals and will support plant growth. It is relatively non-abrasive to pumps, does not compact under prolonged storage, and is non-corrosive to all metals. It has the additional advantage of being very much lighter than borate slurry, the other retardant most widely dropped by fire-fighting aircraft.

Bentonite mixes readily with water, and the resultant slurry can be stored indefinitely.

A report on the use and handling of bentonite, prepared at the Pacific Southwest Forest and Range Experiment Station, U.S. Department of Agriculture, has been received by the U.K. distributors.
F. W. Berk and Company, Limited, Berk House, 8 Baker Street, London W.1.

Honeycomb for Doors

An interesting use of metal honeycomb sandwich construction is in the door panels and covers of the Leo III computer.

The front and rear doors, end covers and ends of tape machines are all constructed with CIBA "Aeroweb" aluminium honeycomb bonded with "Redux" between 0·036 in aluminium alloy skins. The edges of the honeycomb are

surrounded by a standard extrusion and each panel is assembled in one operation. The completed door gives the appearance of solid aluminium and combines extreme rigidity with low weight. Finishing costs are low as the doors provide a perfectly smooth finish with the elimination of spot welds, rivets or other attachments. The illustration shows the Aeroweb honeycomb being cut away and an aluminium block inserted where the panel will eventually be bolted to the main framework.
CIBA (A. R. L.) Limited, Duxford, Cambridge.

No Painting for 20 Years

"Painting the Forth Bridge" has been used for many years as a stock phrase to describe a never-ending job. Few stop to consider the remark as a symbol of corrosion control, but it has been well in the minds of those responsible for creating the new Forth road bridge.

This new bridge will not provide constant work for an army of painters, claim Griffiths Bros., for the steelwork, including the boxes, girders and steel plates, is being treated prior to erection with the Ferrodor metal protection system developed by them said to protect for 20 years.

This is a painting system based on micaceous iron oxide which has been proved a most effective anti-corrosive protective coating when used as a pigment in paint.

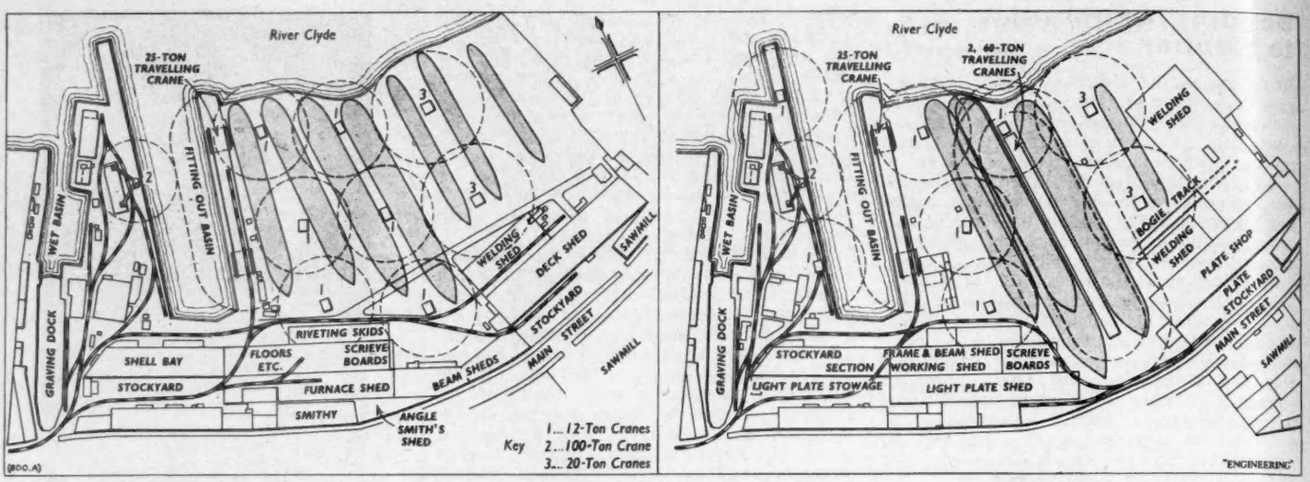
The pigment itself is indestructible, and it is combined with media to produce the Ferrodor paint. The effectiveness of this is said to be due mainly to the natural properties and particle formation of the pigment itself. The particles are flat or plate-like and interleave in a manner somewhat similar to the scales of a fish.

Since micaceous iron oxide is impervious to moisture and highly resistant to ultra violet light it is not necessary to use as much medium in the manufacture of the paint as with an amorphous pigment.

This together with the leafing properties mean that the pigment content can be—and in fact is, say the manufacturers—very high, enabling an exceptionally thick film to be obtained in one coat, without impairing its brushability or the elasticity of the paint film when dry.

It is estimated that each properly applied coat consists of approximately twenty layers of these interleaved particles cemented by, and themselves protecting, intermediate layers of medium of proved durability. Therefore protection is afforded long after the outer film of medium has weathered away.

Details of the complete protecting system for the bridge and the sequence of operations were given in ENGNG., 31 March, '61, p. 449.
Griffiths Brothers and Company London, Limited, 59 Mack's Road, London, S.E.16.



On the left is the 26 acre shipyard as it was in 1948, and on the right is the same yard after modernization. Under the old method ships were built from the keel upwards on the berth. Now, the berths are virtually assembly areas at the end of the production lines.

Clydeside Shipbuilder Moves With Times

A Clydeside shipyard which has been in the business for 250 years has now virtually completed an extensive modernization programme. This has brought it into line with the latest flow production methods of shipbuilding.

HAVING completed two and a half centuries of business on the Clyde, Scotts' Shipbuilding and Engineering Company have celebrated their longevity, not by resting on the laurels of their long history, but by making their shipyard one of the most up to date in the country, and perhaps in the world. The " before and after " story of their modernization programme is shown in outline in the illustration above. They now have a shipyard which can build ships of up to 40,000 tons, and a measure of their progress is the fact that, in the past eighteen months, their maximum unit crane capacity on the building berths has been increased from 12 to 60 tons.

This record makes a pleasing change from the rather sorry tale of British shipbuilding since the war. The industry has been criticized as backward in its production methods and in its research programmes, and it is certainly true that its investment record, usually a guide to an industry's level of efficiency, was poor for at least the first decade of peacetime production.

Even its isolated champions have usually spoken with unconvincing haste and looseness as, for example, when a " quality " newspaper said recently of the fitting out of a new liner that " it was obviously carried out with 100 per cent efficiency." One is left wondering how it was able to establish, never mind measure, 100 per cent efficiency.

Perhaps the most helpful recent statement on the industry was last month's British Productivity Council report (ENGNG., 29 Sept., p. 404) by a combined management/trade union team comparing our shipbuilders with the Swedish industry. The crux of our trouble, said the report, is manpower utilization and human relations. If this is so—and the report made a convincing case for it—it is a pity that the Minister of Transport has chosen a firm of accountants to diagnose for him what ails the industry. Human relations, unfortunately, cannot be recorded as a direct book-keeping entry.

In defence of British shipbuilding, though, it must be said that, in foreign competition, they are at a disadvantage in the face of the extended credit terms made available through some overseas yards. Also, any charge of inefficiency cannot be levelled at the shipbuilding industry alone, for a surprisingly small proportion of the manufacture, and therefore the cost, of a ship is in shipyard work itself. If a shipbuilder does not have an engineering works (this is not true of Scotts', who are in the middle of a big modernization programme in their nearby engineering works) his actual share of overall production might be as low as 20 per cent.

Perhaps the basic problem with British shipbuilding yards is that they were laid out at a time when ships were built from the keel upwards on the berth. When, in the 1950's, new methods of shipbuilding were evolved with the shipbuilding berth becoming an assembly area for sections of hull and superstructure fabricated in surrounding sheds, a new era was begun in the technique of shipbuilding. The new methods made flow production possible and the majority of shipyard workers became virtually factory workers safe from the vagaries of the weather and easier to manage than when scattered over a ship for the whole of its production.

To be brought up to date and to take advantage of these new methods, it is necessary for a British shipyard to carry out a complete modernization programme from the yard gate to the launching ways. This is a major consideration and, perhaps, is one of the penalties of being pre-eminent in an industry before it is revolutionized.

As a leading manufacturer for the Navy—during the war practically all production was for naval purposes—Scotts' gained early and wide experience of welded construction techniques and their yard was one of the first to develop the new technique for merchant ships. In 1952 a new shed, 240 ft long and 160 ft wide with two 20 ton travelling cranes, was opened to increase welding facilities, and in 1956 the first all-welded ship, the 18,255 tons deadweight tanker Caltex Edinburgh, was completed.

INTEGRATED FLOW

Stimulated by this advance, the company then had plans prepared to reorganize the yard to take 40,000 ton tankers and to cover re-equipment up to the most modern standards. £$\frac{3}{4}$ million was earmarked for this huge project, a sum which has been provided from the company's own resources without going to the public.

The basis of the scheme was an integrated flow of work-in-progress from raw material stockyards, through the sheds to the berths, with progressively increasing crane capacity and mechanized conveyance wherever practicable and economic. As shown in the illustration, there were several physical limitations imposed on the scheme by the fact that no additional ground could be made available, the boundaries of the yard being rigidly defined by the river, the main road, another shipbuilding yard and a harbour basin. At no point can the 26 acre yard extend more than 300 yards back from the channel.

This was an important factor in planning the new yard because adequate space was necessary for the storage and processing of prefabricated units. Unavoidably, this had to be at the expense of building berths, which were reduced to four in number, but this is not a limitation on production because so much work is done in the sheds that the time spent on a berth by each vessel has been vastly reduced.

Three of the berths are served by two huge travelling cranes of 40 tons capacity at 150 ft radius or 60 tons at 90 ft radius. In two of the berths, ships of 72 ft beam can be built or, alternatively, a 40,000 ton tanker approximately 730 ft long and 92 ft wide can be accommodated on the combined berth. Ships of 580 ft in length, equivalent to a 24,000 ton tanker, can be built on the third berth. The fourth berth, two 20 ton fixed cranes, is for naval craft.

Parallel flow of sectional material and platework to the welding shed for fabrication is made impractical by the limited width of the yard, and so two stockyards have been set up, at the east and west extremities, with continuous flow from them through the welding shop to the building berths. After shot blasting and coating, if required, sectional material (stored in the west stockyard) is taken by crane through the two bays of the section working shed, a total of 400 ft in travelling distance, whilst being shaped into structural members. The equipment in this shed includes a cold frame bender, a beveller, a beam punch straightener and scrieve boards. Normally, even the largest frame members are shaped cold, but there is a stand-by frame furnace.

In the welding shed, completed structural members link up with the prepared platework. This platework has come originally from the east stockyard where the plate is loaded on to conveyors by a 6 ton magnetic crane. Moving tables then take it, in succession, through high duty plate mangles and shot blasting and thence to the plating shed, the flow of plates having to take two right-angle changes of direction.

A second magnetic crane, installed in the plating shed, lifts the plates on to conveyor tables feeding the individual plate working machines. Along one side of this shed, which is 460 ft long by 90 ft wide, is a Schicau Monopol automatic profile cutting machine capable of

Clydeside Shipbuilder Moves With Times *Continued*

working on plates up to 40 ft long. This interesting machine follows 1/100th scale negatives produced photographically from 1/10th scale drawings made in the mould loft. It can operate on two or more plates at a time, and produces platework with a speed and accuracy considerably in advance of the old system of squad platers. The plating shed also has two 4-headed oxygen flame planing machines, an express rotary shear and plane, flanger and radial drills and a duplex flame cutting machine operating from full size templates and shell rolls.

In the welding shed, which is 360 ft long with two bays 80 ft wide, the completed platework arrives by overhead crane and is assembled and welded to the sectional material to form parts of hulls or superstructures. The total crane lift here is 40 ft, but heavier sections can be tackled, if necessary, by assembling and welding them in two parts and taking them to the building berths separately. Bogie transport is used between the welding shed and the berth cranes.

Now that 60 ton cranes have been installed on the berths, much auxiliary machinery can be placed aboard the vessels before launching. Indeed, the first ship to be built after the installation of the heavy lift cranes had her main engine, a 4,400 hp Scott-Doxford, and all shafting installed before the launch.

LAUNCHING

Scotts' launching facilities have the advantage of being sited where the Clyde is particularly wide and deep, so that launching checks are needed for only the largest vessels built in the yard. The fitting out basin at the west end of the yard opens directly into the channel and is 655 ft long and 160 ft wide with a depth of water at low tide of approximately 30 ft. The west side of the basin is served by a 100 ton and two 12 ton fixed cranes, and the east side by a 25 ton travelling crane. Electric winches are used for the movement of ships in the basin. Parallel with the fitting out basin is a 360 ft long graving dock which is used for the repair and repainting of moderate size merchant vessels. It is ideal for underwater work on submarines and frigates.

Thus, the shipyard's production facilities have been laid out to provide uninterrupted flow of material through all the stages of manufacture. Further, the ancillary specialist departments have all been re-sited to fit in with the overall production plan. X-ray and gamma-ray inspection equipment, for example, has been situated within easy reach of the welding shed.

Since all ship furnishing work, except upholstery, is carried out at Scotts, the joinery department has been carefully planned and sited on two floors of the main administrative building. Close to the graving dock is the plumbers' shop which is fitted with fires, bending machines and all plant necessary to handle the great variety of pipework in a ship. The electrical department, which has been greatly expanded in the last decade, is next to the fitting out basin and is responsible for the whole of the complex electrical installation on board ship.

Across the main road from the shipyard—and not, therefore, shown in the illustration—is Scotts' engineering works. Like the shipyard, the engineering works has unavoidable physical limitations (in that it has the main road in front, sharply rising hills at the rear, other buildings on its two sides and a main line railway bisecting it) but it has been re-planned and is now being re-developed. In fact, this planning and modernization, which began in 1957 and will not be completed until 1962, will cost £½ million.

Scotts, then, now have a shipyard equipped to face foreign competition with a bolder front than has been shown by most British shipbuilders since the war. It is very much to be hoped that this is a development which will be seen as quickly as possible in the rest of the industry.

Scotts' Shipbuilding and Engineering Company Limited, Greenock, Scotland.

Memomotion Study of Dover Car Ferry

Both memomotion and micromotion filming have developed into very useful method study aids and are now widely used by, for example, the Anne Shaw Organisation (ENGNG., 15 Sept., p. 352) as an alternative to direct observation studies. There are many applications where these filming techniques can provide a cheaper and more comprehensive type of study than is possible with a work study engineer's more orthodox type of recording on the shop floor.

One of the stills from a memomotion study of the Dover car ferry terminal.

Another consulting firm, Associated Industrial Consultants Limited, tend not to use filming for work study on the shop floor but there have been occasions when they have found a memomotion camera extremely useful for examining very long cycle processes or in other cases where a study is required over a period of hours. An unusual setting for such a memomotion exercise was a recent study of the Dover Harbour Board's car ferry terminal.

Here, it was decided that a memomotion camera set to half-minute intervals could provide a more efficient working basis for later analysis than human observation. A film made up of stills taken in this way (one of them is shown in the illustration) clearly showed the movement of vehicles through all stages of loading and unloading without any necessity for using up several reels of 16 mm film. AIC have also used this technique effectively in analysing work methods in hospital.

Associated Industrial Consultants Limited, Bush House, Aldwych, London, WC2.

Ergonomically Designed Computer

One of the speakers at the recent International Ergonomics Conference in Stockholm (ENGNG., 1 Sept., p. 280) was Mr. Brian Shackles, of EMI, who gave a paper on the part played by ergonomic principles in the design of the Emidec 2400, claimed to be one of the fastest and most powerful all-transistor computers in Europe.

He described how a general purpose digital computer does not have one fixed sequence of operations but a multitude of sub-routines and functional modes. Its operating is largely controlled by the programme in use at any one time, so that the console must be a sophisticated monitoring station, with manual control facilities accompanied by some diagnostic and fault-finding sections.

In this situation, said Mr. Shackle, "The correct design philosophy must be to group together associated displays and controls, and to locate panels by relative importance and frequency of use, rather than to seek a comprehensive sequential layout."

Colour of lettering, shape of knobs, and distance from operator's seat to furthermost control were only three among the many factors which had to be analysed ergonomically. Ringing bells and Friedland chimes were introduced to reduce the number of visual alarms needed. A window on to the outside world from the computer building was also recommended, as a means of relaxing operator tension.

It is very important that computers and automatic control equipment be designed with ergonomic principles in mind. The operators of such equipment are in charge of very expensive plant and any mistake they might make or any failure to respond immediately and correctly to an emergency could be ruinous for a costly process or recording system. Equipment must therefore be designed for their comfort and to fit in with their natural reactions and, just as important, to prevent the possibility of boredom.

EMI Electronics Limited, Hayes, Middlesex.

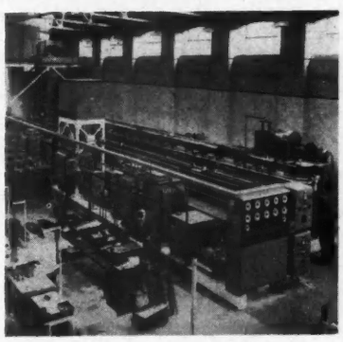
Automatic Plating for Brassworking

Automatic equipment is now being used increasingly in brassworking, though this tends to be an industry where there are pockets of conservatism about—and even resistance to—new-fangled ideas. An example of progress in the industry is the modernization and development programme at the Doncaster factory of Peglers Limited who have installed a Canning Gem extended plating unit.

This is a single line automatic plating plant, shown in the illustration, which incorporates the well proven features of the Trojan design. However, improved operating efficiency and simplified maintenance have been attained by eliminating chains and reducing the number of switches. Where production quantities do not justify a large automatic unit, it appears that this comparatively small fully automatic plating plant can fulfil a useful function.

The automatic installed for Peglers is 56 ft long and has a rated output of 60 jigs per hour giving a plated output of the order of 200 sq. ft per hour. The process is suitable for nickel and chrome and there is provision for copper pre-coating if required.

The process tanks are fabricated as separate units and arranged around the central conveyor



The Gem plating plant installed at Peglers' factory.

so that they can be withdrawn for inspection or maintenance. Where necessary, they can be lined to suit particular solutions. Purity of the electrolyte is maintained—and the number of rejects therefore kept to a low figure—by continuous plating out, which checks the level of metallic impurities, and by continuous filtration, which removes any solids in suspension.

Fume extraction is fitted to all appropriate tanks. Current for the electrolytic cleaning and plating processes is provided by transformers and rectifiers which step down the 400/440 volt three-phase supply to 6-12 volts dc.

In addition to increasing output and quality of product, the new plant makes possible vastly improved working conditions. In this factory, the plater no longer wears his traditional uniform of aprons and boots.

W. Canning and Company Limited, Great Hampton Street, Birmingham, 18.

XUM

On the Shelf

By Frank H. Smith

THE September issue of the *Chartered Mechanical Engineer* had one of those cosy little items that are rapidly becoming commonplace in the professional bodies. Entitled " How the Departments Work " it kicks off with " The Senior Staff Structure " and then, in the opening paragraph, becomes more guarded. In place of the word " work " they substitute " operate," thus frustrating any attempts at sarcasm from dissatisfied members. A chart shows to whom each branch of the staff is responsible and one might wonder why the editors are responsible direct to the secretary while the librarian is responsible to an assistant secretary. It has always struck me as peculiar that, in some institutions and societies, the man considered capable of dealing with queries on more subjects than any member is required to take in his exams (including common sense) is often comparatively junior. The same thing happens in factories, so it must be something connected with the librarians' modesty I suppose. They are not pushing enough. Why don't they have a sit down protest somewhere? In the British Museum courtyard for instance.

As a result of buying the Gagarin record from Collet's (70 New Oxford Street, London W1) I got tons of literature on discs of all sorts including a huge list, in type rather smaller than the *Times* Personal column, of Folkways Records, which include a special section " Science Series 12 " with such titles as " Sounds Steam Locomotives " 1, 2 and 3); " Sounds of Science Fiction "; " Sounds of Sattelites " (*sic*; their sounds may be authentic but their spelling is not); " Sounds of Medicine " (tummy rumbles?) and so on. Lashings of good clean fun.

I do not know how three of a kind stands in poker but that's what three leaflets from Interscience look like. *Natural and Synthetic Fibers Yearbook 1960* at $60; *Quality Control and Applied Statistics Yearbook 1960* at $60; and *Resins Rubbers Plastics Yearbook 1960* at (you've guessed?) $60. Am I wrong in thinking it unusual for a yearbook to bear a date a year behind the date of publication? All of these, by the way, are collections of abstracts issued during the year to contributors.

In case it has not got through to some of you yet, the Department of Scientific and Industrial Research (Big Brother) has moved from its fashionably-situated headquarters at Charles House, Regent Street, London W1, to the thumping great State House, High Holborn, London WC1 (CHAncery 1262). They are afraid of flooding in High Holborn, hence the house on stilts, but what of a bomb? Cor mate, what a tumble. And what a charming name the DSIR Press Officer has—Norman Manners.

Remember my reference to the NRC Bibliography from C. A. Parsons? (look back three or four weeks to p. 318 and give yourself a treat in the process). They've now sent me No. 2 in the series, a 132 item *Bibliography on boiling heat transfer*.

The Decca Navigator Company Limited have produced a booklet called " Pictorial Presentation." It is worth getting, simply as a specimen of pictorial presentation, although the title itself refers to their navigation system.

I have had a leaflet from General Electric (US) extolling the virtues of their new Space Technology Center (ground breaking, April 1960; planned completion, December 1961). Of course it sounds like a research man's dream of heaven, but what caught my fancy was the location: " 17 miles west of Philadelphia at the junction of the Pennsylvania Turnpike and Schuylkill Expressway adjacent to Valley Forge State Park in King of Prussia, Pennsylvania." That is redolent of something or other, but whether it is Cadillac or covered wagon I cannot make up my mind.

Concrete Advice

A Guide to the B.S. Code of Practice for Prestressed Concrete No. 115 : 1959. By F. WALLEY and S. C. C. BATE. *Concrete Publications Limited, 14 Dartmouth Street, London SW1.* (12*s* 6*d*)

The British Standard Code of Practice, No. 115, " The Structural Use of Prestressed Concrete in Buildings " was published in 1959 and is the first Code of Practice issued by the British Standards Institution on this subject. The present book is a commentary on the Code which is reproduced in full and is identified by black marginal lines. Both authors were members of the committee which prepared the Code and had a substantial share in its drafting. They are therefore qualified to comment on it.

The book is addressed to engineers concerned with the design and execution of prestressed concrete. Although the idea of prestressed concrete originated in the last century, its practical application as a structural material is comparatively new. It started in France in the late twenties of the present century, but its development on a large scale began only during the Second World War. Since the end of the war progress has been very rapid both in this country and abroad. Nevertheless, there is still much scope for further research and improvement of our knowledge. For this reason, in drafting the Code, particular care has been taken to avoid restrictions which would hamper the future development of prestressed concrete construction, and in some of the clauses, therefore, the final decision is left to the engineer who thus carries greater responsibility than with longer established methods of construction. In other clauses, lack of information has limited the extent of recommendations made, and their interpretation in practice also depends on the judgement and skill of the engineer. Consequently, an authoritative guide to the Code is much needed.

The book is written in very clear language and can be easily understood by engineers who are qualified to undertake the design of prestressed concrete. It contains many tables and diagrams supplementary to the Code which are useful either as a clarification of the Code or as means of saving time for the designer. The latter applies particularly to data on the losses of prestress due to the relaxation of the steel, elastic contraction, shrinkage and creep of the concrete and friction. The diagrams and tables relating to the proportion of the shearing force to be resisted by reinforcement under working load and to conditions for ultimate strength in bending and in bending combined with a compressive force are also very helpful.

As the authors state in the preface, to avoid confusion the terminology used in the commentary is identical with that used in the Code. There is, however, one notable exception to this rule. Whereas the Code speaks of " loss of prestress, due to creep of steel," the authors also use the term " relaxation." Needless to say that in this respect the terminology of the Code is not correct. " Creep " means the change of length in time due to an applied stress, whereas " relaxation " means the reduction of stress in time at a given strain and it is this effect for which the Code recommends that a reduction of prestress in the steel by 10,000 to 15,000 lb per sq. in should be allowed in the design.

An index and a good bibliography, frequently referred to in the text, are included.

It is regrettable that the lettering of the diagrams is of poor quality. This, of course, does not affect the practical value of this excellent book which can be highly recommended to everybody engaged on the design of prestressed concrete.

K. HAJNAL-KÓNYI

Handbook for Civils

Civil Engineering Reference Book. 2nd Edition. Edited by J. COMRIE. Four Volumes. *Butterworths.* (£17 17*s*)

The essentials of a good reference book are: a comprehensive index, an authoritative text, wide scope and a good bibliography. This book has all these and is not only an excellent reference book but is also an extremely interesting review of up to date civil engineering practice.

A comparison with Rankine, on which our fathers were brought up, illustrates not only how massively our knowledge of civil engineering has widened and deepened, but also, how the manner and style of its practice have suffered a revolution. It may be argued that as the scope of civil engineering is now so wide, a comprehensive book such as this, should give way to a number of reference books, such as Guthrie Brown's *Hydro-Electric Engineering Practice* and Cornick's *Dock and Harbour Engineering*. But, after spending many hours completely absorbed in Comrie's book, I am sure that for many years to come, it will serve a most useful purpose.

The second edition is a great improvement on the first, though it is still somewhat uneven in its coverage. The four volumes are more convenient than one unwieldy one. Six new chapters have been added, of which one is outstanding: " Hydraulic Power Plants," by Dr. Jaeger. This is a model of conciseness and clarity and has a wide scope and excellent bibliography. " Overhead Transmission Lines " is also very well written and has an extensive bibliography. " Structural Concrete " covers the subject very thoroughly but could be condensed drastically and still meet the needs of the practising engineer. " Prestressed Concrete " presents a brief but useful description of the main methods and design procedure, but it would be useful if more practical details were given, for example, equipment used in prestressing, typical construction details and examples of post-tensioned precast unit construction. Practical examples of masonry structures are completely lacking in the chapter dealing with masonry and brickwork. It is refreshing to read a dissertation on aesthetics: too often it is assumed that only architects have eyes to see and a feeling for beauty and style in their work—though it must be admitted that many bridges erected recently make one shudder.

Volume I deals with mathematics, physics, chemistry, mechanics, strength of materials, surveying, building materials and measuring appliances. " Strength of Materials " has been revised. The theory of thin slabs and shells is well stated but might be expanded in view of the amount of work done in this field in the last decade. " Surveying " has been brought up to date with a number of useful paragraphs, the most interesting being the use of electronics and radar in long distance surveying. " Building Materials," a subject of the utmost importance to the civil engineer, should be expanded with more practical details.

Volume II opens with first class concise up-to-date chapters on soil mechanics and site investigation both with excellent bibliographies which have been considerably extended. No revision has been made to " Foundations and Earthworks," which should be expanded and revised; caissons, coffer dams and piling are all inadequately treated and need bringing up to date. Tunnelling warrants at least double the number of pages and one would like to see far more on construction plant and methods, tunnel linings and compressed air tunnelling, as well as comparisons of tunnel sections and records of progress in different types of material. Hydraulics of canals and rivers has been rewritten and

is adequately covered while coastal engineering is dealt with in a concise, balanced and interesting way, well set out and illustrated. The volume ends with an excellent practical account of explosives.

Volume III is concerned with structures: mainly bridges and buildings. The chapter on theory of structures has been improved with a considerable extension to the section dealing with relaxation methods. Structural iron and steel is well covered in a revised text with added tables of properties and useful details of friction grip bolts. Well illustrated chapters on steel bridges and bearings are excellently set out and cover the subject adequately. Then follow interesting discussions on long span bridges, welding and welded structures, but welding has assumed such an importance that one would welcome much more on this subject. The chapter on steel building structures is disappointing. It could be much condensed and would be better if written on the lines of that on steel bridges with more design information and practical details. Reinforced concrete and timber structures are both well treated with good design information, but light alloy construction should be expanded to include design methods and worked exmples.

In Volume IV the treatment of both highways and railways is disappointing and badly needs revision. Illustrations of obsolescent roundabouts should be replaced by modern interchanges and many of the railway structures look very outmoded. Airfields are adequately covered but " Harbours and Docks " deals inadequately with quay walls, jetties, dock gates, caissons, slipways, dredging and dredgers (worthy of a chapter on its own) and requirements for special cargoes (bulk handling, oil, etc.). Water supplies and sewerage are good chapters but those on town planning and fire protection might be omitted. That on works construction is most useful, but the organization suggested for a large contract is not a good one and should be omitted or revised. The legal notes are useful, but a much fuller discussion on arbitration procedure would be helpful.

One is glad to see a number of contributions by continental engineers and this practice might well be extended in the next edition. It is hoped that this will include chapters on: thermal and nuclear power stations (siting, layout, foundation and cooling water problems, etc.); use of models to aid design; irrigation (might be coupled with land drainage); corrosion and maintenance (cause and effect, prevention and cure, paints, metallic coatings, cathodic protection, etc.); dredging; engineering economics; and costs and estimating. It does seem strange that cost estimating is hardly mentioned throughout the book, in spite of its fundamental importance to the engineer and his client.

This book is thoroughly to be recommended and is well on its way to becoming the standard reference book for the civil engineer.

D. P. BERTLIN

Nostalgia for Steam

Pacific Steam: The British Pacific Locomotive. By MARTIN EVANS. *Percival Marshall.* (12*s* 6*d*)

Nigel Gresley: Locomotive Engineer. By F. A. S. BROWN. *Ian Allan Limited, Craven House, Hampton Court, Surrey.* (35*s*)

The great age of the steam locomotive is past. There has been in consequence quite a large number of books written of late in apotheosis of the steam locomotive age and the men who fashioned it. So let it be while those of us are around who have memories worth recording of the great locomotive runs of the first half of the 20th century.

In their different ways, both these books are a record of the achievements of steam in the first half century. They dove-tail. *Pacific Steam* is a straightforward record of the development of the Pacific locomotive in this country from 1908 to 1954 when the first and last Pacific types appeared from railway workshops. It is a slim and modest work, well supplied with plates of different examples of Pacifics, which will appeal to all lovers of locomotives.

The book on Sir Nigel Gresley is a more ambitious undertaking. It is a full and painstaking account of the career of one of the most distinguished locomotive engineers this country has known. Perhaps the word to describe Gresley's work is " elegant." His achievements flowered at a time when labour was still comparatively cheap and an intellectually satisfying solution need not pay too much regard to maintenance problems. The chronicle of Gresley's work on both locomotives and rolling stock is here carefully set out from his appointment at Doncaster in 1905 to the great L.N.E.R. Pacifics of the A classes that reached their full development in the 1930's.

In the current enthusiasm for recording in loving detail the development of the great mechanical achievements of steam locomotion, there is some danger of getting no further than antiquarianism—important as that may be up to a point. One cannot always see the men and the managements, the technical problems and how they were solved, for the glowing accounts of the working parts and the admiration for the finished products that came out of the workshops.

There are indications of this in this book on Gresley. There is yet scope for a book which will see quite objectively all the aspects of the steam locomotive age. The steam locomotive stood in a sense not only at the heart of the development of mechanical engineering but also at the centre of British industrial development. Its achievements and failures were part, and an important part, of the story of British industrial management and technical achievement right through the industrial revolution.

In Mr. Brown's book there are hints of these great problems of decision and growth of organization, but no more than hints. All sorts of questions are raised in the reader's mind and the answers are not here. For example, why was Gresley (and for that matter Stanier and the others) who had adapted more than a few excellent ideas from the French and Americans, so slow to see (and admit?) the dawn of the age of the diesel? Was there any real stimulation between the mechanical engineers of the four great railway systems or was there only emulation? Certainly there could not be real competition for each ran their own systems of permanent way. Were the great Pacifics the dinosaurs of the railways (big, beautiful but infertile) or has something gone wrong since?

Was there something wrong with the system of command which let the nationalizers in? The answers to these and like questions have important lessons for the future not only for the railways but also for British industry in general.

G. E. TEWSON

Industrial Organization in France

Organisation Technique de l'Entreprise Industrielle. Edited by LOUIS PEHUET. *Editions Eyrolles, 61 Boulevard Saint-Germain, Paris 5e.* (92·75 *NF*)

The post-war upsurge of industrial activity in Western Europe, of which so much is heard in this country, has been particularly striking in France. After a slow and difficult start in an almost devastated economy, French industry has set its sights firmly on expansion and there is much talk of doubling industrial output in two to five years. Substantial results have already been achieved. The French share of the world's exports of manufactured goods has gone up by 7 per cent since 1953, while the British share has fallen by 12 per cent. And greater productivity coupled with higher efficiency has caused French export prices to go down by 7 per cent over the same period, indeed by the largest amount for any industrial nation, whereas those of Britain have gone up by 10 per cent. French manufacturers are convinced that, with the Common Market, this is only the beginning; over the last year alone their exports to the Common Market countries have doubled.

This climate of expansion embraces not only the large and well-known enterprises, but all industry down to the smallest works, and it is in the latter that growing pains are most acutely felt. Management techniques evolved on a man-to-man basis—production control by the chief engineer-draughtsman or bookkeeping by the secretary-telephonist—will no longer do when the staff has grown from 10 to 100 or more and the annual turnover has reached six figures (in sterling). Hence this is a timely moment for the appearance of a large and comprehensive if rather elementary treatise on *The Technical Organization of the Industrial Undertaking*.

The book is addressed to the French scene, and should be of particular value to the small *entrepreneur* and to those who now come face to face with problems of industrial organisation for the first time. But no doubt it will have appeal beyond this circle, as a work of reference for management and as a textbook for students not only of industrial administration but of engineering at large, since there is increasing awareness that student engineers ought to learn something of the functioning of industry where the majority of them will work.

Nevertheless, the book concerns itself mainly with the larger enterprise, the reason given being that smaller units are too diverse in size and character to permit adequate treatment of their problems. This is not necessarily a fault because the small man may like to think ahead in a period of expansion and may glean much from the experience of his larger colleague, but it would have been an advantage if his problems had attracted a little more discussion.

In a brief introduction Louis Armand, one of the great engineer-administrators of the Western World, compares an industrial undertaking with the cell in a living organism, the proper functioning of which both in itself and in its relation to the other cells is quite vital to the economic and social well-being of the whole. Here, as elsewhere in the text of the book, we have an interesting and perhaps typically French attitude to industrial organization; it is not a matter of lifeless charts and patterns, but it is a living thing in which human relations play the predominant role.

The book has been produced by a team of 21 authors drawn from public and private industry and from technical colleges, and directed by Louis Pehuet, the honorary engineer-in-chief of the French National Railways, which at once testifies to the high standing both of the railways and of engineers in France. In 24 chapters and 850 pages, it covers the whole gamut of industrial organization in its widest sense, from production planning and standardization to profitability,

budgetary control, personnel management and industrial safety. These are all topics commonly discussed but not commonly understood, and the object of the book is to provide a basis either for initiation into the field or for further study of particular subjects, helped in some chapters, but not all, by a brief bibliography. The production is excellent, the diagrams are numerous and clear, and the only slight blemish is the absence of a subject index which makes the following-up of a particular point of interest a little awkward. Style and presentation are good and only a moderate knowledge of French is needed to follow the text.

In the United States, the authors say, the spectacular economic progress of industry must be attributed to the care given to its organization; 53 per cent of all firms with a payroll of more than 250 have their own specialized "organizing" departments (running of course under many different names), and one in 17 of all the engineers in industry is engaged on this work. Such a level has not been attained in France (nor indeed in Britain) and it is implied that perhaps it should be. But one may wonder whether the widespread employment of outside management consultants has not somewhat reduced the need for specialized internal staff, and whether there is still a case for striving after a position which arose in the United States under different, and now almost historical, conditions.

Ideas on personnel management, with strong advocacy of performance grading for staff and labour, seem right up to date. Yet in another field, that of office mechanization and automation, the book is strangely at variance with recent trends. Among the large number of typical production documents shown by way of illustration there is, for instance, not a single punched card. Manual methods of stock control are suggested which, in larger firms at any rate, were on their way out even before the war. And production planning, on which there is some excellent material in the book, must surely now take cognisance of automation in some form or other. It seems here that the authors are perhaps unduly influenced by experience in public undertakings which are faced with different production problems and supply only a limited variety to a limited market, and where therefore a more elementary approach may be justified. This approach also eases understanding by the novice who, confused perhaps by the rival claims of commercial equipments, comes best to grips with fundamentals by seeing how things are done the long way round.

For the British reader, the book provides a valuable insight into industrial thinking in France. He will note the enthusiasm and the will to succeed. Not all the methods suggested may seem to him quite as modern as his own ideas and those filtering across the Atlantic. But he should not be misled by such examples as a proposed stock control sheet for 20 mm drawn steel bar which has 20 headings and 14 vertical columns, all laboriously to be filled in by hand; he will find French industry a powerful force when he meets it on equal terms in the Common Market.

K. GOLDSMITH

New Books

1960, Seventh National Symposium on Vacuum Technology: Transactions. Edited by C. ROBERT MEISSNER. *Published for the American Vacuum Society Inc. by Pergamon Press.* (£7 7*s*)

Seventy-odd papers were presented, ranging over a wide variety of problems in vacuum science and engineering. Of considerable current importance is the section on thin films.

Metallic Fatigue. By W. J. HARRIS. *Pergamon Press.* (84*s*)

A mass of theoretical and experimental data has been digested to give an authoritative and comprehensive picture of the various factors involved in the fatigue mechanism: stress concentration, frequency effects, corrosion, fretting and crack propagation. The statistical character of fatigue is discussed and certain standard aircraft fabrication and finishing processes are described. Nearly 400 references are cited.

Technology, Engineering and Safety. Volume 3. Edited by C. M. NICHOLLS. Progress in Nuclear Energy, Series 4. *Pergamon Press.* (£5 5*s*)

Collection of 15 authoritative reviews of various aspects of reactor engineering and technology, ranging from gas bearings for compressors, through fuel element technology, to reactor emergency shutdown equipment.

Combustion and Propulsion: Fourth Agard Colloquium, Milan, April 1960: High Mach Number Air-Breathing Engines. Edited by A. L. JAUMOTTE, A. H. LEFEBVRE and A. M. ROTHROCK. *Published for the Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, by Pergamon Press.* (£5 5*s*)

The current and future developments in hypersonic aircraft are examined in relation to their propulsion systems. Among the topics discussed are ramjet developments and performance, hypersonic inlet characteristics, diffusion flames and detonation waves, nozzle flow with chemical reactions, turbomachinery, and high-temperature materials.

Engineering-Technical Drafting and Graphics. By J. W. GIACHINO and HENRY J. BEUKEMA. *American Technical Society, Chicago; Technical Press, London.* (80*s*)

Detailed exposition of current drafting techniques in the USA based on a study of the practices of numerous industrial engineering drawing departments.

Engineer Apprentice Manual. *Trade and Technical Press.* (42*s*)

Compiled from selected articles which appeared over a period of ten years in the now defunct journal *Engineer Apprentice*, this is a practical reference manual for the workshop floor, not a textbook. The articles range from machine shop practice through foundry practice to a survey of electric motors.

Workshop Technology: Part 3. By W. A. J. CHAPMAN. 2nd Edition. *Edward Arnold.* (35*s*)

Taking cognizance of the advances during the past 10 years in workshop techniques, the author has thoroughly revised this standard work for HNC courses in production engineering.

Principles of Structural Design. By NIELS LISBORG. *Batsford.* (50*s*)

Mr. Lisborg is concerned with the region where the architect and engineer meet and have common problems to solve. The approach caters for students of architecture, structural engineering, building and surveying who are preparing for statutory examinations; for architects seeking creative designs based on sound structural principles; and for engineers who are stimulated by imaginative solutions.

Elementary Statics of Shells. By ALF PFLÜGER. 2nd Edition. *F. W. Dodge Corporation, 119 West 40th Street, New York 18.* ($8·75)

A simple and methodical introduction to shell theory and design is offered, which largely avoids rigorous mathematical solutions and aims to set forth a visual interpretation of the spatial interplay of forces in shells. This is a translation of the 1957 edition of *Elementare Schalenstatik*.

The Elementary Principles of Reinforced Concrete Design. By W. H. ELGAR. *Architectural Press.* (18*s* 6*d*)

The treatment is designed for students of architecture and building surveying, and therefore the author is almost entirely concerned with buildings and the related codes of practice. An understanding of stress and strain and their relationship, and of the shearing forces and bending moments in simple beams is assumed. There are no fully worked-out examples of the design of structures.

Failure and Repair of Concrete Structures. By S. CHAMPION. *Contractors Record Limited, Norfolk Street, London WC2.* (35*s*)

Although the chemical and mechanical deterioration, failure and repair techniques of concrete structures are the main concern here, brickwork, masonry, precast stone and precast concrete are not overlooked. There is a chapter on floor and road surfaces and special attention is paid to the waterproofing of joints and cracks.

Soil Mechanics in Road Construction. By CHRISTOPHER F. ARMSTRONG. *Edward Arnold.* (63*s*)

General survey of the role of soil mechanics in highway engineering, couched in a concise form suitable for the practising engineer.

Boilers: Types, Characteristics, and Functions. By CARL D. SHIELDS. *F. W. Dodge Corporation, 119 West 40th Street, New York 18.* ($15)

This is for industrial engineers who are responsible for the design, installation and operation of equipment for generating heat and power. The material is organized within six major sections: Boiler classification; Boiler design; Steam generating equipment; Boiler construction; Industry regulation; Industry status. The codes of practice and standards cited refer only to the USA. There is little theory, but a wealth of descriptive and practical information.

Vibration Mills and Vibration Milling. By H. E. ROSE and R. M. E. SULLIVAN. *Constable.* (25*s*)

The authors have assembled a wealth of information on vibratory grinding—much of which is derived from their own researches at the King's College Powder Science Laboratory (London)—and from it have developed a theory which is used to suggest new designs of mill and to indicate how best to obtain maximum efficiency in grinding.

The Reviewers

Dr. K. Hajnal-Kónyi, Dipl. Ing. E.T.H.(Zürich), Dr.-Ing.(Darmstadt), is a consulting engineer. He is a Member of both the Institutions of Civil Engineers and Structural Engineers, and a Fellow of the American Society of Civil Engineers. He was a member of the drafting committee for CP 115 : 1959.

Mr. D. P. Bertlin, M.Eng., is senior partner in a firm of consulting engineers. He has had considerable experience of both construction and design in connection with hydroelectric schemes, dock engineering, and prestressed concrete work. He is an M.I.C.E., M.Cons.E. and M.Soc.C.E. of France.

Mr. G. E. Tewson, M.A., is a partner in the firm of O. W. Roskill Industrial Consultants.

Mr. K. Goldsmith, M.Sc. (Eng.), A.C.G.I., widened his engineering training by attending the London School of Economics. He is a full Member of both the Institutions of Mechanical Engineers and of Electrical Engineers. His experience includes apprenticeship in Belgium and Switzerland and positions at Unilever and the Central Electricity Authority. He is now with Merz and McLellan, the consulting engineers. Chief interests are in the field of technical and economic planning.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Tools and Equipment

Crankshaft Grinders. LANDIS TOOL COMPANY, Waynesboro, Pa, USA. A catalogue of 16 in and 25 in hydraulic crankpin grinders. Describes design features and equipment. Typical applications of the grinders are illustrated. Specifications of the two types are given, together with dimensioned diagrams. 24 pp., ill.

Machinery Catalogue. THOS. W. WARD LIMITED, Albion Works, Sheffield. A comprehensive catalogue of machine tools and machine-shop equipment, sheet-metal working machinery, woodworking machinery, small tools and accessories. Sections are also devoted to power plant, compressors and pumps, foundry and forge plant, and electrical plant and equipment. 164 pp., ill.

Processing Scrap. SHEPPARD AND SONS LIMITED, Bridgend, Glamorgan. A catalogue of the Scrapmaster range of machines for the fully automatic shearing, baler/shearing, or baling of almost every type and size of scrap. 16 pp., ill.

Mining Equipment. WESTINGHOUSE BRAKE AND SIGNAL COMPANY LIMITED, 82 York Way, London N1. A leaflet, 25A, describing a power delay valve which enables the rate of flow of compressed air applied to a pneumatic ram or cylinder to be varied after a given interval of time. A booklet, CP11, referring to single- and double-acting pneumatic cylinders. Sizes and types range from 4 in by 4½ in single-acting to 8 in diameter double-acting cylinders with a stroke of 8 ft. Dimensioned diagrams of all types are included. 19 pp., ill.

Marketing

British Firm to Produce American Valves

Continuing the theme of Anglo-American cooperation in industry, a production and marketing agreement has been concluded between DOWTY HYDRAULIC UNITS LIMITED, Ashchurch, Gloucester, RUBERY OWEN AND COMPANY LIMITED, Darlaston, Staffordshire, and the HYDRAULIC UNITS SPECIALITIES COMPANY, of Waukesha, Wisconsin, USA.

The agreement will utilize the manufacturing facilities of Rubery Owen, who will produce the full range of Husco hydraulic control valves at present manufactured in America by Hydraulic Units. The Dowty distribution network will be responsible for marketing throughout Britain and Europe.

The valves are compact in design being of monoblock construction. The makers claim high efficiency and their versatility makes them suitable for a wide range of applications. They will be available with from one to six spools having built-in load check valves and high-pressure carry-over features. Also series-parallel, parallel, and series circuits together with various combinations of these may be obtained within the same valve block. 120 combinations are available, providing a capacity range of up to 158 Imperial gallons per minute. This in addition to the existing Dowty manufactured hydraulic control valves will make the range one of the most comprehensive on the European market.

From the consumer's point of view, one of the advantages of such an agreement, must be that it enables him to purchase a well-proven product designed by a firm possessing considerable experience in the particular specialist field, and yet still be in a position to obtain a rapid on-the-spot technical advisory and after-sales service. This may be done without the necessity for long-distance negotiations or contact with an appointed agent who may sometimes lack the finesse of a larger concern already well-versed with the diverse problems associated with the particular product.

Plastics Sales Establish Record Level

During the second quarter of 1961, figures published by the Board of Trade show that sales of plastics materials in the United Kingdom reached a new record level. 158,200 tons were sold, this being 10,800 tons higher than the previous best recorded during the first quarter of 1960.

The improvement is largely due to increased exports and the replacement of imported with UK produced materials as home consumption for this period is only slightly up on last year. Exports during the quarter amounted to 46,300 tons, nearly 10 per cent greater than the corresponding period in 1960, although slightly lower than the first quarter. Imports were 20,300 tons, a decrease of almost 22 per cent against last year, but once again this figure is slightly less favourable than that for the first quarter of 1961.

The largest percentage increase was in the sales of polyolefines (polyethylene and polypropylene), and polystyrene, which both showed increases of 27 per cent. Thermoplastic materials which constitute the bulk of the plastics manufactured in the UK sold 103,000 tons, an increase of 15 per cent.

The figures are derived from the returns of some 170 firms actively engaged on the manufacture of plastics materials. Synthetic resins for use as textiles are excluded.

Plessey Expand Hydraulic Activities

Following an announcement last April that the PLESSEY COMPANY LIMITED had concluded a licence arrangement with the German company, GULDNER-MOTEREN-WERKE, preparations are now well under way for the production of "Hydro-Stabil" hydraulic equipment.

Plessey have recently acquired a 50,000 sq. ft factory, close to the existing headquarters of their Industrial Hydraulics Division to house the production equipment. It is planned that operations will be phased to achieve a full manufacturing programme during 1963/4. The first phase will be the complete factoring of Guldner equipment and this will be followed by the assembly of piece-parts from Germany as an interim step towards full production at Swindon.

Hydro-Stabil units have already been successfully applied in Germany to provide hydrostatic transmissions for many types of vehicle, and are particularly valuable where ease of control and manoeuvrability are necessary. Among vehicles already equipped are a wide range of mechanical handling equipment, shunting locomotives, delivery vehicles and road rollers. Applications are not limited to transport but the units can in many cases be applied to such things as ships winches, mobile cranes and machine tools.

New Ship for the Channel Services

ALEXANDER STEPHEN and SONS LIMITED of Linthouse, Glasgow, have received an order from the BRITISH TRANSPORT COMMISSION to build a new 7,000 ton passenger ship for the British Railways cross-channel services. Due to commence operation on the Eastern Region's night service between Harwich and the Hook of Holland in mid-1963, the new vessel, the largest employed on the channel run, will replace the "Duke of York" which was completed in 1935.

750 passengers will be carried in two classes, 600 of them accommodated in the 280 cabins fitted with sleeping berths. Amenities will include a restaurant, cafeteria and separate lounges and smoke rooms for 1st and 2nd class passengers. There will also be provision for cargo and a limited number of cars.

The new ship will be 404 ft long with a moulded breadth of 57 ft 6 in. It will be powered by a twin-screw geared turbine giving a service speed of 21½ knots and fitted with Denny-Brown/AEG stabilizers. Extreme manoeuvrability in harbour will be facilitated by a bow rudder and a bow side thrust unit.

New Ferro-chrome Smelter for S. Rhodesia

Power derived from the Kariba Dam is to be used to operate a new smelting plant to be erected at Que Que, S. Rhodesia by WINDSOR FERROALLOYS (PRIVATE) LIMITED with JOHN MILES and PARTNERS as consulting engineers. Rated at 7,500 kVA, the new smelter will produce initially some 12,000 tons of high-carbon ferrochrome per annum using local chromite ores. Windsor Ferroalloys has taken over Windsor Chrome Mines which have operated for some years in the area and work on the new plant is to commence immediately.

The head of the new company, Mr. Leo H. Timmins, who previously held a controlling interest in the Windsor Mines has, together with his two Canadian associate directors, invested over £300,000 in Rhodesia, a country offering wide scope for development of its rich natural resources. The smelter is expected to increase this capital outlay to over £1 million.

British Pavilion at Peru Trade Fair

The British Pavilion at the Pacific International Trade Fair to be held at Lima, Peru, in October will have a steel framework pre-fabricated by COSELEY BUILDINGS LIMITED, of Wolverhampton.

The pavilion, built to the order of the Board of Trade, will measure 125 ft by 180 ft and consist basically of four standard buildings arranged in a square, leaving a spacious open area in the centre. The interior lay-out and the front elevation of light and dark blue panels above a base of clear English glass has been designed by the Central Office of Information.

The Fair will run from 11 to 29 October and be inaugurated by President Prado of Peru. British industry will be represented by 30 individual stands on which a wide variety of equipment will be displayed, including marine diesel engines, mining equipment, and contractors' plant in the heavy range and washing machines and hand tools amongst the domestic appliances.

BTC Order More Diesels

Continuing British Railways steady switch from steam to diesel locomotion, the BRITISH TRANSPORT COMMISSION have placed orders for a further 27 complete main-line diesel railway locomotives. In addition, ancillary equipment including diesel engines and transmissions has been ordered bringing the total value of the contracts placed up to about £2¼ million.

The largest order for seventeen 1,750 hp locomotives, worth about £1 million, goes to the ENGLISH ELECTRIC COMPANY whose Preston and Newton-le-Willows factories will be engaged in the production. Delivery is scheduled to commence in October, 1962, and they will be based in the Hull area under the North Eastern Region.

The other ten, to be used on the Eastern Region's Sheffield area services, will be made by the BRUSH ELECTRICAL ENGINEERING COMPANY. They are to have 1,365 hp engines and will be due for delivery early in 1962. All these locomotives will have the electric transmission system in which the diesel engine drives a generator to provide electric current for traction purposes.

BRITISH UNITED TRACTION LIMITED are to supply the additional equipment comprising primarily twenty 235 hp diesel engines and transmissions and twenty sets of control equipment. All these will be used in the construction of ten 4-car multiple-unit trains in the railway workshops at Swindon. They will come into service next year when the Western Region introduces its new inter-city diesel service between Swansea and Birmingham.

AEI Speaking Clock for Sudan

Sudan is to have a speaking clock installed on four telephone exchanges and has chosen a typist in the Sudanese Embassy in London to be its first "Girl with the Golden Voice."

ASSOCIATED ELECTRICAL INDUSTRIES will be responsible for the system which will come into service on 17 November, the anniversary of the date when the present Sudanese Government came into power. It will enable subscribers in the Khartoum and Omdurman areas to dial the correct time in either Arabic or English.

The installation, designed by AEI Telecommunications Division, uses a tape recording system synchronized by a crystal controlled master clock which, it is said, ensures accuracy to less than one second per month. This accuracy can be maintained independently of power fluctuations as the equipment runs on the exchange battery supply.

During the last 2½ years, AEI have been engaged on the development of a speaking clock which is claimed to be the cheapest yet available for the facilities which it can provide. These could include, if required, time messages in up to five different languages giving wide scope for the insertion of short advertisements between the actual time announcements. Such a provision would enable the authorities to recover the cost of the installation very quickly.

Massey-Ferguson Sales Up

Despite the adverse effect of drought conditions on the important combine harvester markets in the United States and Canada, the value of MASSEY-FERGUSON world sales for the nine month period ended 31 July increased by 3 per cent to £130 million.

Net income, however, was down by £1,300,000 due mainly to the lower level of activity in North America and in France where there was also a decline. The increased level in the U.K. and other parts of Europe had failed to offset this completely.

Announcing these figures, Mr. A.A. Thornbrough, president of the Group, said that present trends were encouraging; corrective marketing measures taken in North America during the last quarter appeared to be showing results and sales in Australia were progressing satisfactorily. The tractor plant in Coventry was operating at full capacity and the combine plant at Eschwege, Germany, had been unable to meet the European demand. He went on to suggest that aggregate sales for the whole of 1961 might well achieve a record level.

XUM

The Sterling Borden Airotor "60" Dental Drill

The evolution of the first air turbine dental drill handpiece and its subsequent ramifications—perhaps the biggest technical advance in dentistry since the last century.

NOBODY likes going to the dentist and the reason is not far to seek; it is the fear of pain caused by interference with the tooth's delicate nervous system.

The practice of giving some form of anaesthetic to a patient having an extraction mitigates to a large extent the unpleasantness of tooth removal. It is with the more common operation of preparing a cavity for filling, using a dental drill " handpiece ", that pain and dread are equally associated.

As this Product Profile will show, the coming of the air turbine handpiece and its tremendously increased burr speed has gone some way towards eliminating pain, since its vibrations are so rapid as to be well beyond the patient's perception. The turbine also affords the dentist a corresponding increase in speed of penetration and hence more effective utilization of his time.

When the Borden Airotor handpiece was first shown at Rome in 1958, it received instant acclaim on account of its astonishing performance. It was the immediate demand by dentists all over the world for the new tool that led to the multiplicity of types of equipment now on the market. The Borden Airotor was the first; and it is still one of the best. It is marketed by many leading dental equipment firms in the world in association with their own ancillary control equipment, including the Amalgamated Dental Company in Britain under the trade name " Sterling ".

Consider for a moment the crippling physical limitations of a dental handpiece such as the Airotor " 60 ". The head, little bigger than $\frac{3}{8}$ in diameter and $\frac{1}{2}$ in long, contains a rotor spinning at anything up to 300,000 rpm, with its shaft carried in two tiny ball bearings. The shaft itself has to be hollow, with in this case a polythene sleeve for retaining the drill bit or burr. As if the size limitation were not enough, the whole mechanism must be capable of being boiled in water for 20 minutes or heated to a higher temperature in an autoclave, for sterilization purposes. What other piece of precision mechanical equipment has to be boiled regularly as part of its everyday existence? For this reason, stainless steel is extensively used.

LOGICAL OUTCOME

Dental drill handpieces as a whole are a logical outcome of an accepted requirement. Before a cavity in a tooth caused by decay can be filled permanently and effectively, the overlying enamel and all unsound dentine material surrounding the cavity must be removed. Next, the bottom of the cavity must be opened out into such a shape that it will retain the filling material firmly when it has solidified. It is during the final shaping of the cavity that pain is most likely to be felt, as it probably involves cutting through sound and often sensitive dentine.

A hundred years ago it was usual to fill teeth with cement or cohesive gold. The enamel was removed by hand chisels, and long-handled burrs twisted between finger and thumb were used on the dentine. Preparing a cavity was a painfully slow process, urgently needing mechanization.

During the 1860's clockwork and even hydraulic means were tried for imparting continuous rotation to the burr, but the first satisfactory solution was the treadle engine of 1872, in which a flexible final drive to the handpiece was successfully applied. Electric drive appeared in 1883; and the final stage in the evolution of the well known and often dreaded dental engine of today took place in 1910 with the provision of an endless cord transmission in place of the cable drive.

By now a wide range of handpieces, burrs and abrasive wheels had been developed to suit the various dental operations, being improved and added to with the passage of years. The dental engine is still useful for certain operations and remains a standard piece of dentist's equipment. Its chief limitations are the bulk and unwieldiness of the cord drive, and the speed ceiling of about 15,000 rpm—or 30,000 rpm with a speed increaser. The unpleasant jarring set up when using speeds of this order is one of the most potent causes of pain, and years of research have been directed towards an increase. By raising the maximum speed ten or twenty times the air turbine handpiece has achieved the desired objective, and has led to a whole range of new and generally smaller burrs.

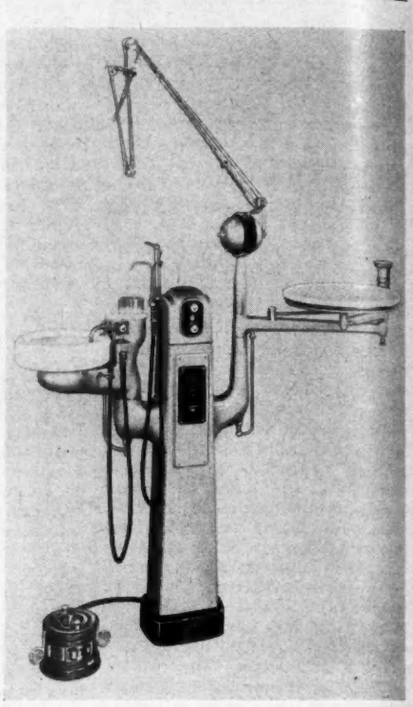


Fig. 1 Conventional dental unit with cord drive to drill handpiece.

Development of an ultra high speed turbine handpiece was pursued in several countries after the War, notably in America, Sweden, and by the Amalgamated Dental Company in Britain. It was a practising dentist in America, Dr. John Borden, D.D.S., in collaboration with the Dentists' Supply Company, who finally succeeded in producing an effective and reliable turbine handpiece. He used miniature stainless steel ball bearing assemblies (to carry the rotor shaft) which had appeared on the market in 1953. They instantly overcame the troubles with sleeve bearings that had been dogging every experimenter; the air turbine handpiece had, in fact, been waiting for a technical advance.

Thus was born the first Borden Airotor. The Amalgamated Dental Company and several others lost no time in abandoning their own

Fig. 2 Original Borden Airotor replaceable turbine cartridge complete; and dismantled to show ball bearings, two halves of casing, rotor, etc.

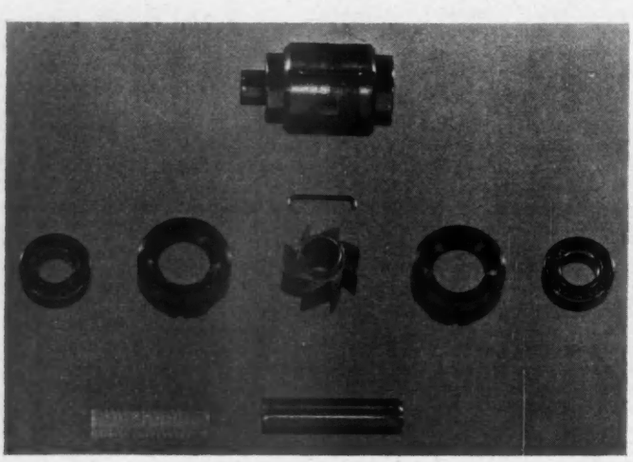
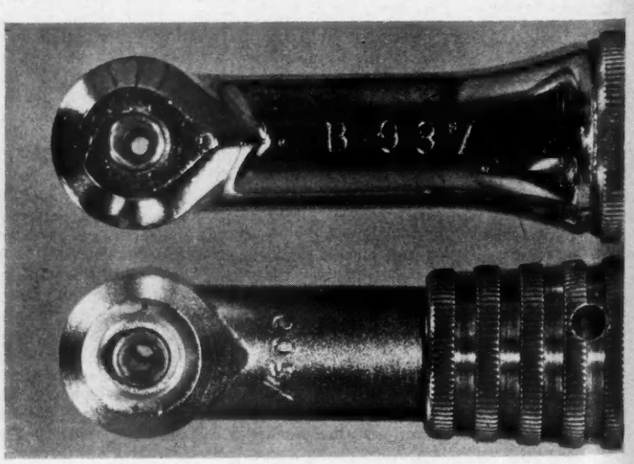


Fig. 3 Comparison between head of Airotor 60 with two coolant orifices and no underside exhaust (lower), and earlier Borden (upper).



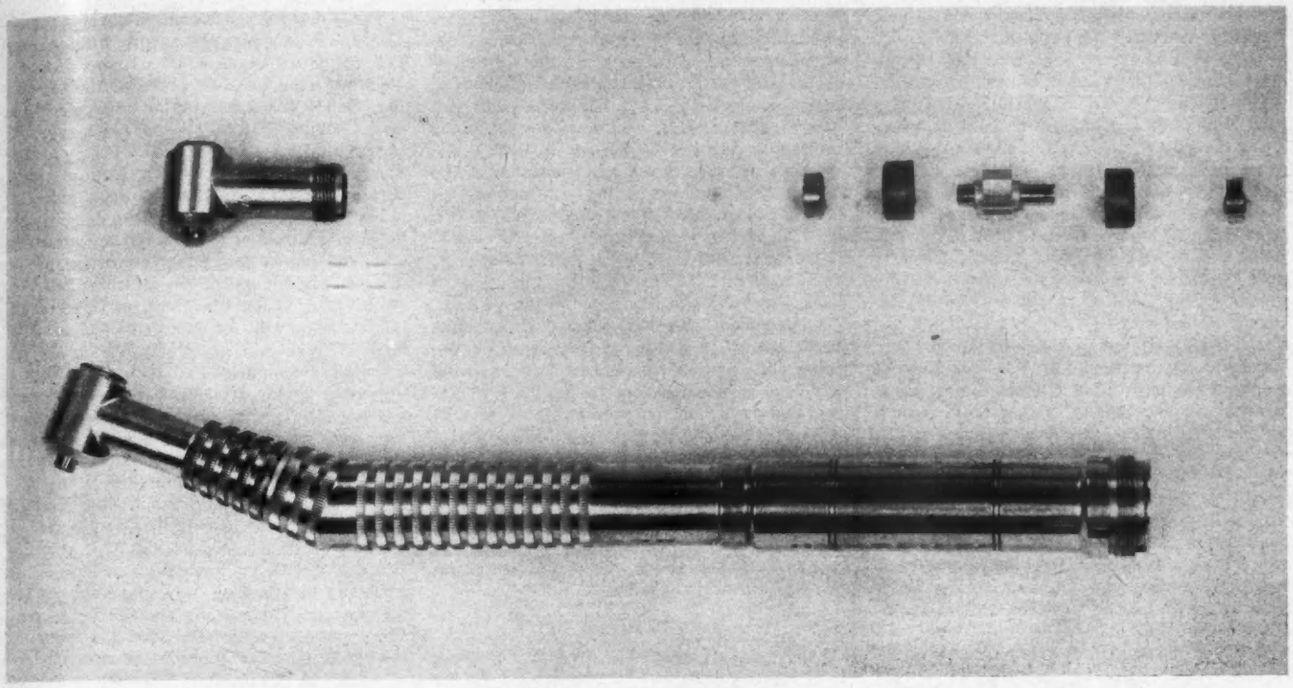


Fig. 4 A new component (miniature bearings) made possible a new tool (turbine dental drill).

experiments and entering into agreement with the American company for marketing the Borden in their own countries, for which they started making up their own sets of control equipment.

Subsequently, KaVo, a West German company, took out a licence agreement for manufacturing the Borden on behalf of those companies operating in sterling areas, and Amalgamated Dental now obtain their handpieces from KaVo. The curious situation exists that at least two other firms also market the Borden in Britain, the S. S. White and Ritter companies. Other firms have since developed handpieces of their own, very similar to the Borden, of which those of the Dental Manufacturing Company (Britain) and Sandri (Italy) are perhaps the best known.

Despite the basic simplicity of the Borden, changes have occurred as a result of operational experience. The biggest drawback of the air turbine is its high pitched whine created by the siren effect of the air passing over the rotor blade tips. This noise is to some extent unavoidable, since it is inherent in the nature of the tool. Any deliberate attempt to silence it must result in increased back pressure and loss of torque; and the ultra high speed turbine handpiece is essentially a low torque machine. Later variations of the design are, however, less objectionable on this count.

The first Borden handpiece exhausted air in no less than five places: at the back of the head, at the rear of the handpiece and through three small orifices at 120° around the burr, as shown in Fig. 3, to blow the cooling water spray towards the burr tip. A spray or jet of cooling water, hitherto very much a refinement in a dental handpiece, assumes vital importance with the turbine, since the burrs or diamond abrasives used at its speed develop considerable local heat.

The Airotor 60, introduced in 1959, has two diametrically-opposed cooling water orifices directing the jets towards the burr tip, so that even when working in deep cavities one or other of the jets will always reach the burr. Air is no longer exhausted on the underside of the head but through a mushroom shaped cap on the top so as to be less perceptible to the patient.

Early production Borden handpieces differed from the prototype in having the rotor shaft and bearing assembly encapsulated within the head, the intention being that a dentist would only need to carry one complete handpiece and a spare capsule to allow for repair or replacement without interrupting his surgery. In the Airotor 60 the capsule arrangement was abandoned in favour of providing each handpiece with two interchangeable heads. Without the capsule the head could be made 10 per cent smaller.

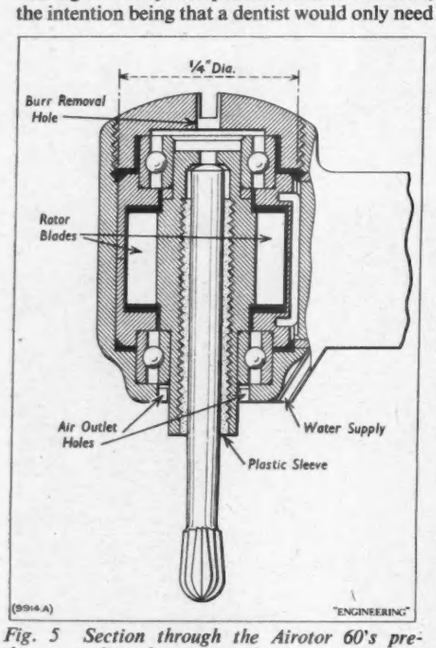


Fig. 5 Section through the Airotor 60's predecessor. (No drawing of the current machine is obtainable.)

An air pressure of 60 psi is required at the turbine head, and is usually provided by an outside source. A suitable compressor is one of Amalgamated Dental's many other products. In common with all other turbine handpieces, continuous oil-mist bearing lubrication is provided by a lubricator interposed in the air line.

An important refinement which does not affect the design of the handpiece itself is an electric heater for the cooling water. This provision may seem paradoxical, but raising the temperature slightly is far more comfortable for the patient's tooth and does not noticeably detract from cooling efficiency. The heating element is carried in an unobtrusive metal tube assembly in the supply line a few inches behind the handpiece. Though the cooling water and air supply hoses are contained in a common line to the handpiece, the effect of the water heater on air temperature is negligible.

ANCILLARY EQUIPMENT

The success of a tool like a dental handpiece must necessarily depend to some extent on the ancillary equipment, without which it would be useless. Amalgamated Dental market three sets of equipment with the Airotor 60.

The Airotor I and III control units are similar in that they each comprise a small cabinet designed for mounting on the arm of a dental engine; or, in present day parlance, the engine arm of a dental unit as shown in Fig. 1. Control of the turbine and water spray is performed independently by a pedal arrangement so that the final details of the cavity can be completed without spray if desired. The quantity of water discharged by the twin jet arrangement of the Airotor 60 is above average and the dentist does not switch the jets on until the burr starts to make contact with the patient's tooth.

The Airotor I control unit contains basically the same standard industrial components as the American prototype comprising the air filter, manually operated air pressure and water flow control valves, lubricator, and solenoid valves for release of both air to turbine and water to jets operated electrically by the pedals.

It was soon found that some dentists disliked the complication of electrical connections as well as water and air, and inspired by successful non-electric control installations introduced by other companies, Amalgamated Dental produced the Airotor III. It is the subject of the lower view in Fig. 4. Since it has a built-in heater it cannot truthfully be described as non-electric, but the solenoid operated valves of the Airotor I are replaced by simple mechanical air valves. An added advantage is that air pressure, and hence turbine speed, is controllable by foot movement alone. Other improvements include a cable drum handpiece retraction system, improved styling, and an air gauge.

The Airotor IV is a mobile control unit; it carries its own water supply and, since it has no heater, requires only an air connection.

The turbine handpiece demands new operating techniques which dentists had to master—a gentle stroking action in place of applied pressure. It has also inspired refinements of other dental equipment. Apart from the special air compressor and burrs, such items as larger capacity saliva ejectors (for removing the coolant), spinning mouth mirrors and mouth lamps have all been developed.

The Amalgamated Dental Company controls a group of companies with a world wide organization employing about 4,000. It was formed in 1925 by an amalgamation between the two leading London dental houses, the de Trey company and Claudius Ash Sons and Company. The factory employs about 800 making every conceivable piece of dental equipment from a chair to forceps, excepting only turbine handpieces.

Not only is the field of dentistry highly competitive, demanding a relatively large travelling sales and service force, but the market for any new piece of equipment like a turbine handpiece (which every dentist must have) tends to become quickly saturated. In semi-developed countries, however, there is a steady demand for all types of surgical equipment and such areas form an important section of the market. Amalgamated Dental also believe in bringing themselves to the notice of dentists early in their career, by doing their best to ensure that their equipment finds its way into dental schools.

Air turbine drills are also finding industrial application, and Amalgamated Dental are currently directing research in that direction. Current trends in less specialized fields are gradually finding their way into dentistry too; for example building all dental facilities into a single piece of equipment aimed at expediting the dentist's work with minimum effort and loss of time. In Britain, with less than one dentist to every 3,000 persons, it is fortunate in one sense that the policy of trying to educate everyone to have their teeth examined regularly at six monthly intervals has hardly started to bear fruit, since dentists are already overworked. Increasing the dentist's turnover of patients, and increasing the amount of up-to-date equipment on the market in step with the growing number of dentists, offers the dental equipment industry a double challenge.

Amalgamated Dental Company Limited, Amalco House, Broadwick Street, London W.1

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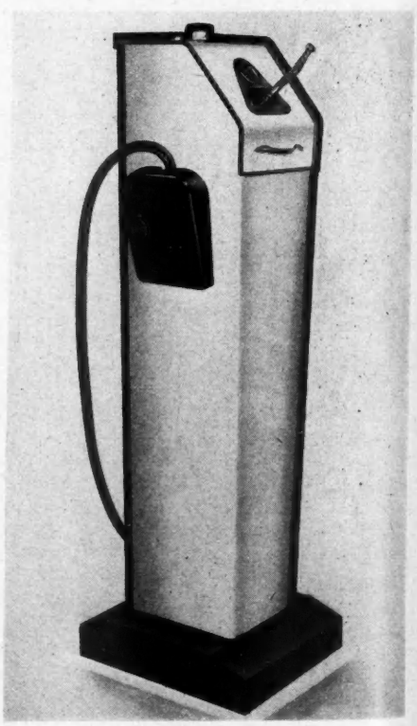


Fig. 6 Airotor IV mobile cabinet and pedal.

Ultra-Pure Tungsten Shown to be Ductile

A practical method of producing large single crystals of tungsten has been announced by the Westinghouse Electric International Company, New York, USA. Developed in conjunction with the company's space research programme, the new technique also produces tungsten of very high density and purity.

Tungsten rods ten inches long and a fifth of an inch in diameter are being produced as single crystals. By using newly developed refining techniques, it is said to be possible to grow the crystals in predetermined crystalline forms with purities up to 99·9975 per cent. The large crystals of tungsten are big enough to permit commercial manufacture of small parts from them.

Tungsten is commonly considered to be a hard, brittle metal which is very difficult to machine or fabricate. However, Westinghouse engineers have shown that ultra-pure single crystals are actually ductile, even at temperatures as low as —330°F. They have shown that ductility depends on purity. This discovery points to the possibility of a major breakthrough in commercial fabrication.

High purity single crystals are of particular value in studies of the fundamental properties of high temperature metals. Tungsten, having the highest melting point and greatest strength of all metals is a particularly promising material for applications such as rocket motors.

The development of large single crystals of tungsten was the result of a research programme aimed at a deeper knowledge of the fundamental properties of tungsten, which is already a key component in the lamp, electronic and missile industries.

Since tungsten metal was not available in a suitable form for such studies, Westinghouse engineers designed an original zone-melting apparatus using electron beam heating in order to produce larger and more pure crystals. However, to attain crystals of a high degree of purity, it was first necessary to develop a process for making special high purity tungsten ingots. These ingots are used in the zone melting process as the starting material from which the crystal is grown.

When the ultra-high purity crystals were finally attained, Westinghouse engineers then found that existing analytical techniques were not sufficiently sensitive to obtain precise measurements of gases and metallic impurities when they were present in only a few parts per million. As a result, advanced methods of optical spectroscopy, vacuum fusion and neutron irradiation analysis have been developed.

Laboratory for Aircraft Generation Systems

A new laboratory for the testing and development of aircraft generation systems by the Plessey Company Limited is now operational, and is expected to step up to full load during the next year. Situated at Eastern Avenue West, Romford, Essex, the plant has been "custom built" to the specification of the Plessey works engineers department and the laboratory staff. It covers a floor area of 15,000 sq. ft.

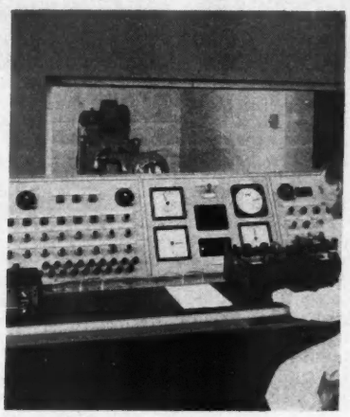
The initial installation, currently making proving tests on a four-generator system of 160 kVA total for the Vickers VC10, is capable of handling four paralleled channels of equipment up to 120kVA normal load per channel with complete simulation of any environmental conditions likely to be met by aircraft of the next decade.

Future projects include systems testing for the BAC 111 and for military aircraft. The generator drives have a speed range in excess of 3 : 1 with controlled acceleration up to 1,200 rpm per second and a capacity of 200 hp per drive. Three-phase loading, both resistive and reactive, is variable between zero and 150kVA per channel. The comprehensive cooling facilities installed enable direct simulation of supersonic flight conditions.

To ensure that fully proved systems are available to the aircraft industry from the commencement of a project, the Plessey Company have installed what is believed to be the most advanced system of automatic testing for generation electronic control equipment in the world.

The work is carried out by point-to-point fault location consoles, which can be programmed by punched tape for automatic continuity and wiring verification on any type of control or ancillary unit. The equipment enables years of flight experience to be obtained in a few hundred hours.

A hot and cold chamber enables small associated equipment to be checked over the entire environmental temperature range. Temperatures obtainable range from —60°C to 120°C,



Proving tests are currently being made on a 160kVA, four-generator system for the Vickers VC10.

and this range can be totally encompassed within one hour.

The laboratory has been planned with the large surrounding residential area in mind, and sound-proofing ensures that testing work causes no annoyance to people living nearby. A paint spray and impregnation plant now under construction is designed to ensure that 100 per cent of the excess paint is disposed of harmlessly.

In addition to the main engineering and testing bays, the building includes such departments as a drawing and design office, a receiving inspection section for incoming systems, a photographic darkroom, administrative offices and stores. A 1·5 MVA sub-station has been installed by the Eastern Electricity Board to meet the added demand on the public electricity supply.

The establishment's work is backed by the facilities and engineering experience of the Westinghouse Corporation of America, under whose licence the VC10 system is being manufactured. Plessey personnel are also working in close cooperation with the British aircraft industry.

Despite the fact that operations have only recently commenced at the plant, much work is already being done in investigating future trends in aircraft generation systems. The project has the support of the scientific resources of the entire Plessey Group.

New Source of Polarized Protons

A device which produces polarized protons has been successfully used on the 50 MeV proton linear accelerator (PLA) at the Rutherford High Energy Laboratory of the National Institute for Research in Nuclear Science, Harwell.

The technique provides a beam of protons which are 32 per cent polarized at an average intensity of 3×10^7 protons per second. A polarized beam is one in which the protons are spinning predominantly in a fixed direction relative to their direction of motion.

Nuclear forces are known to be spin dependent and, because of this, if the beam is polarized it enables a greater range of experiments to be performed, and consequently more detailed information can be obtained about the particle interactions. The successful development of this source is therefore of considerable importance.

Although several other laboratories are known to be working on similar projects, it is believed that this is the first source to be installed in a large accelerator and to produce a beam of protons of sufficient intensity to be useful for nuclear experiments.

The source works as follows: hydrogen atoms are produced from molecular gas by a radio-frequency discharge. These atoms then pass through a high-intensity non-uniform (6-pole) magnetic field in which atoms with positive magnetic moment oscillate about the axis and emerge from the magnet as a well defined beam. By bombarding this beam with a current of electrons, the atoms are ionized, and the resulting protons which are then extracted and injected into the linear accelerator are polarized. This polarization is preserved during acceleration.

The polarized proton source is located on the 500 kV terminal of the dc injector of the accelerator. Thus, it was necessary to make the vacuum equipment, comprising seven pumps, the control equipment, refrigerators and water cooling plant, completely self-contained and self-monitoring. The experimental work in the laboratory, followed by the engineering design and manufacture, took about three years to complete.

Technique for Making Semiconducting Diamonds

The Research Laboratory of the US General Electric Company has discovered methods which make it possible, for the first time, to produce semiconducting diamonds. Such diamonds are extremely rare in nature, but can now be grown in laboratories by a high-temperature, ultra-high-pressure process developed by General Electric.

Semiconducting borazon has also been made successfully, according to Dr. G. Suits, director of research. Borazon, which is a cubic form of boron nitride, has a structure very similar to that of the diamond and is equally hard.

The method of making semiconducting diamonds was discovered by Dr. R. H. Wentorf (who also developed the process for making borazon) and Mr. H. P. Bovenkirk. Diamonds are made semiconducting by adding impurities such as boron, beryllium or aluminium to the mixture of graphite and catalyst from which diamonds are made.

The mixture is subjected to pressures of about 1,000,000 lb per sq. in and temperatures above 2,000° F. Under these conditions, diamonds form with concentrations of 1 per cent or less of the desired impurity, and have electrical conductivities in the semiconducting range.

Semiconducting diamonds have also been prepared by diffusing boron and aluminium into man-made and natural diamonds at high pressures and temperatures. All the semiconducting diamonds made so far have been p-type (positive current carrier). Both p-type and n-type crystals are necessary in transistors and other semiconducting electron devices, and a search for processes that will produce n-type diamonds is continuing.

Both p-type and n-type crystals can be produced in borazon and one type can be grown on a seed of the other type to form p-n junctions, which exhibit rectifying properties.

Beryllium as an impurity produces p-type borazon, and a number of substances including sulphur, silicon, various organic compounds, and potassium cyanide, result in n-type borzaon when added to the synthesis mixture.

Experiments on the purification of turbid water have shown that the coagulation process is dependent on the water's acidity.

Stream velocities being measured in an experimental catchment near the Laboratory's Headquarters at Medmenham.

Increasing Britain's Water Reserves

Abundant supplies of cheap wholesome water are absolutely essential to any modern community, yet, more than any other engineered material, piped water is taken for granted. The Water Research Association exists to ensure that increasing demands will be adequately met.

WATER demands for industrial, agricultural and domestic purposes are rising rapidly in Great Britain, and there is a definite danger that demand will exceed supply within the foreseeable future. Figures published by the Ministry of Housing's Central Advisory Water Committee show how nearly we will have come to exhausting our present water capacity within the next four years, when it is estimated that gross daily demand will be 4,500 million gallons and supply will only be 4,650 million gallons. These figures are worsened by the fact that they do not account for future plans for agricultural irrigation which, in a dry season, may demand as much as 240 million gallons per day by 1965.

The demand for pure water increases steadily at a rate of about 2½ per cent per year. Natural underground sources have now reached the limit of exploitation so that further supplies, in the near future at least, will have to come from direct use of surface water.

Research Report

on work of the

Water Research Association, Medmenham, Buckinghamshire.

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These factors warrant very serious attention, which is why in 1953 Britain's water industry, in conjunction with the DSIR, decided to establish and finance the Water Research Association. Research work began in 1955 but, until recently, the scale of work carried out by this Association has been modest, due mainly to restricted laboratory accommodation and the fact that they were not situated near enough to an abundant supply of raw water. However, the WRA, once again aided by the DSIR, have now managed to establish new research quarters on the banks of the River Thames at Medmenham, Bucks., where their laboratory facilities and raw water supply will allow for a greatly expanded research programme.

After only four months at the new laboratory, research is already in fairly full swing, the work being divided into five main sections: chemistry, physics, biology, hydrology, and plant processing.

Chemistry

The most important work being carried out by the Chemistry Division is a study of coagulation. In this process, the tiny suspended particles which cause water to be turbid are coagulated into a floc which can then be easily removed by a settlement or a filtration process. This technique of water purification has been in use for many years but, until recently, no serious attempt has been made to understand the physical-chemical processes of coagulation. Such an understanding has now become important due to the need for an increased use of surface waters.

One interesting result of research on this topic has been the discovery that the pH factor of the water being treated is often critical to the process, governing both the amount and type of coagulant to be used.

Aluminium sulphate, one of the commonest coagulants in current use, has been found to be effective in only a small range of water pH values so that, unless the pH of the water is adjusted in some way, other coagulants may be far more effective. By either adjusting the pH of the water, therefore, or producing some cheap alternative coagulant, water undertakings may now be able to process a greater volume of water with their existing plant. Alternatively, they may be able to treat the same volume of water as before at a lower cost.

In some parts of Britain, the problem is one of removing dissolved colouring matter rather than suspended particles. This is also performed by coagulation but the mechanism involved is thought to be different. Studies aimed at determining the nature of this process are now under way.

The concentration of colouring matter in raw waters is usually very small. A technique for the extraction of colour on a fairly large scale had therefore to be developed in order to provide material for analysis and test. The apparatus which was developed for this operation is now in use, processing river water at a rate of 100 gallons an hour. The method provides for the adsorption of organic matter on a highly porous anion exchange resin in the chloride form and removal by subsequent elution with 10 per cent sodium chloride solution. The technique has proved to be very effective but there is difficulty in removal of the sodium chloride from the concentrated organic extract. A study of this problem is complicated by the wide molecular weight range of the compounds involved.

Physics

The main concern of the Physics Division is to study the application of plastic materials to the construction of water mains and service pipes. This work is coupled with instrumentation, particularly for the detection of leaks and analysis of water distribution networks.

Among the new materials being developed and experimentally tried out for water mains and service pipes, plastics are probably the most important. Since they are not subject to corrosion as iron and steel pipes are, plastics offer the advantages of longer service life in corrosive conditions and lower rates of water loss through leakage. Plastic pipes are much lighter and easier to handle than their iron and steel counterparts and their installed cost, particularly in the smaller sizes, may be less.

A small quantity of plastic pipe was laid in Germany before the war and in Holland after the draining of the Polders in 1948. But these pioneer distribution systems are still very young in terms of the service life to be expected. If there were precise information available about the long-term strength characteristics of such pipes it might well be possible to produce them more cheaply, particularly by reducing the wall thickness. This is the object of the Water Research Association's present investigations. The programme includes accelerated tests of fatigue caused by variations of pressure in the system and tests for the effects of sudden shocks and extremes of temperature.

Since the loss of water by leakage is estimated to be at least 10 per cent of the volume actually delivered to the consumer, it is obvious that the

water engineer urgently requires some method for detecting leaks in mains more quickly and accurately. With this ultimate object in view, the Association has developed a device for transmitting information from inside the main to an observer several feet away.

The instrument is a simple, transistorized, electronic unit which generates magnetic pulses by opening and closing a solenoid relay. When this transmitter is inserted in a main, its precise position can easily be determined by using a receiver which picks up and amplifies the magnetic signals.

The signals from this type of transmitter have not been found to be strong enough to overcome the shielding effect of a thick iron or steel pipe. However, a similar device which uses a rotating bar magnet instead of a relay has now been developed to give a more powerful signal.

At the moment, the only practical use for the transmitter is to detect the whereabouts of any large obstruction, such as a cleaning plunger, which may get stuck in the pipe. However, with further development, it should be possible to attach transducers and couple them to the relay (or rotating magnet) so that they can vary the signal frequency and thus transmit information about the physical characteristics of any part of the system.

The narrowing margin between capacity and demand has also created a need for the development of a practical method of calculating the performance of complicated networks under various probable conditions. Such calculations can of course be made manually but are exceptionally time-consuming. The Physics Division is therefore making studies of the possible application of both analogue and digital computers to produce rapid methods of precise calculation.

Hydrology

Hydrology is the study of water between its reaching the ground as rain, snow, dew or hail, and its entering the sea or being lost by evaporation. One of the problems of research in this field is that many of the factors involved are difficult to measure precisely. For example, evaporation occurs not only from open water, such as streams and lakes, but also from moist soil and foliage. It may also be lost from vegetation (by a process known as transpiration) even when the surface of the soil is dry. Water that escapes evaporation either infiltrates into the ground or runs off into streams and rivers. While river flow can be measured accurately, infiltration can only be inferred.

The hydrological research requirements of Britain's water industry at the moment are fourfold:

(1) Techniques for calculating how a given reservoir capacity will cater for the fluctuations in the natural supply of water and in the consumer's demands. The risk of a reservoir running dry must be balanced against the cost of a larger reservoir and it is here that accurate hydrological data are vitally important.
(2) Studies of the effects of different types of land use upon water yield. In the British Isles very little information is available even now on the effects of various types of vegetation and methods of land use upon the yield of water from the catchment areas. Several Continental countries and the USA have made considerable progress in this sphere and their results suggest a number of ways by which substantially increased yields might follow the application of hydrological research data.
(3) Measurement of the water bearing properties of the formations which store underground water and assessment of their long-term yields in terms of infiltrating rainfall. Thirty per cent of the raw water taken by water undertakings in the British Isles comes from boreholes, wells and springs. As natural replenishment is a very slow process, supplies will not stand up to extravagant consumption.
(4) Guidance of projects for the artificial replenishment of underground water. If the technical difficulties can be overcome, artificial replenishment offers storage at low capital cost. Sweden, Germany, the Netherlands and the USA have made use of this idea, but it has not yet been adopted in Britain.

The Water Research Association's work in this field is part of an integrated national programme of hydrological research. At the moment, the Hydrology Division is devoting its main attention to surface waters, and its aims are as follows:

(1) To encourage the widespread improvement, both in quality and quantity of hydrological measurements made by water undertakings.
(2) To advise water undertakings on methods of using their own hydrological data to better advantage.
(3) To cooperate in the scientific study of evaporation and rainfall measurement in upland catchment areas of Britain.

The first aim is, of course, a long-term one which should eventually provide data for the accurate planning of future demands. Information on techniques of instrumentation is being assembled and necessary devices which are not already being developed elsewhere may be developed by research teams of the Association.

The second object will nearly always involve the specific problem of determining the yield of catchment areas. In some cases, the necessary data for a proper statistical approach already exists. Normally, however, only the rainfall is known, and that often inadequatley, so that an estimation of the yield must rely upon " inspired guesses " as to the losses by evaporation and ground diffusion.

An experimental programme has been initiated to assist in the determination of catchment evaporation for different kinds of cover in an upland catchment in the Derwent valley, on the border of Northumberland and Durham, and in the techniques of rainfall measurement in hilly areas. The evaporation studies will embrace measurement of wind speed, water vapour pressure and net radiation balance at various points over selected catchments.

An experiment has also been devised on a catchment near the Association's research laboratory where pit rain gauges may be tried on exposed sites and the rainfall distribution in the valley determined. The study will provide an example of instrumentation techniques for visiting water engineers and a climatalogical station is planned with the same intention.

Plant Process

Processes carried out on large-scale water treatment plant are subject to problems which do not arise when they are performed on a laboratory scale. A water purification plant consisting of two treatment processes running in parallel and using water extracted from the Thames nearby is now being designed and will be installed in the pilot plant laboratory.

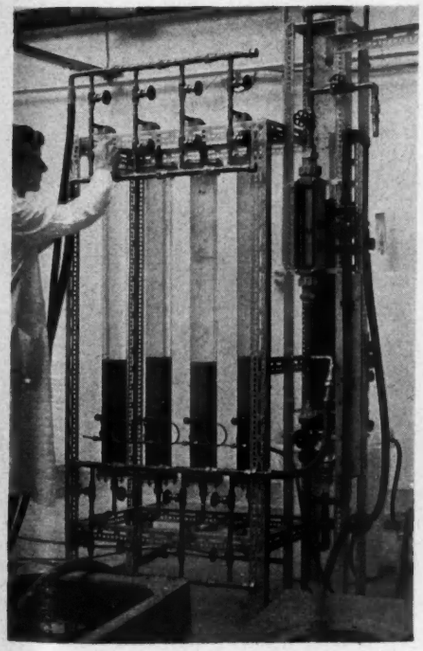
It will have three main uses: (1) To investigate existing water treatment processes; (2) to develop from the findings of the Chemistry Division new processes which may be applied to full-scale water works plant; (3) to investigate particular problems which may occur in the plant of members of the Association.

The pilot plant will be large enough to ensure that processes developed in it can be transferred to full-scale plant without further difficulty, but small enough to be flexible in operation.

Biology

The biological aspects of the water supply process are clearly of great importance, not only because biological purity is required equally with chemical purity but because biological as well as chemical processes are used in water purification.

The Biology Division has only recently been established, however, and a first examination of the problems is now being made. It will be concerned with a wide range of subjects including aspects of water sterilisation, the speeding up of bacteriological examination and the control of algae in stored waters.



(Left) An apparatus has been developed to isolate coloured organic matter from natural water at a rate of 100 gallons per minute.

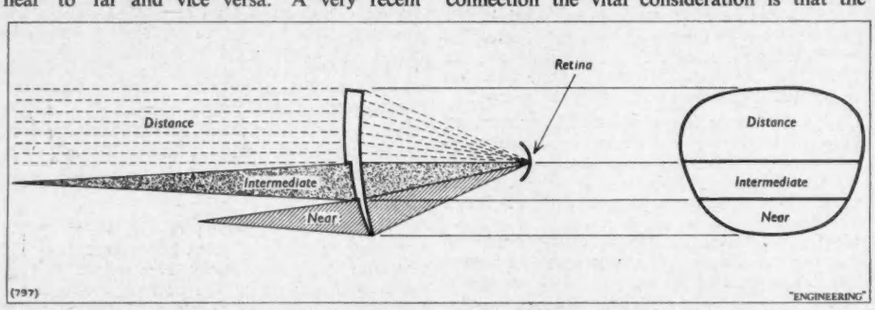
(Right) Trials are being carried out with an electronic device which has been developed to transmit signals from buried water mains.

Watch Those Eyes

THERE must be very few jobs indeed in which the eyes do not play a leading part—and even fewer recreations. But all eyes are not perfect and many jobs impose a considerable strain on them. Moreover as they age there is a tendency for normal vision to deteriorate because the eye lenses harden.

In this country, some 21 million people wear glasses and it is expected that during the next year more than 4½ million new pairs will be prescribed under the National Health scheme; they will have to serve their wearers for both work and leisure. This means that they must be suitable for both close and far vision, a combination that is virtually impossible. But if the eyes do not function easily work suffers, both as a result of the actual indistinctness and from the headaches caused by eyestrain. The only solution for many people is to have two pairs, one for near and the other for distant vision (with the attendant nuisances of changing them and remembering to have the other pair at hand). The alternative is to have bifocals; that is, lenses cut to have two areas of different focal length.

It is generally thought that bifocals are a recent development but in fact they date back some while; Benjamin Franklin wore them about two hundred years ago. (Glasses themselves of course go back much further). However, production difficulties held back any general use of bifocals until only a few decades ago but now they are regularly prescribed for those whose work involves frequent changes of focus from near to far and vice versa. A very recent introduction are the trifocals which offer even greater advantages, though of course they are more costly.



Trifocal glasses offer the older man focused vision at three distances. For instance they allow a man working a lathe to read an instrument, follow the progress of the turning and move freely in the shop.

The use of trifocals is being urged by the Information Council of the Optical Industry who are conducting a general campaign for the more considered use of glasses for all purposes. In their booklet *The Over-Forties and Their Seeing Problems*, they use carefully chosen examples to pinpoint how the presbyopia of middle life can be countered by the selective choice of glasses. In particular they raise this point of having to adjust to a wide range of distances.

One of the examples put forward from industry is the man working on a lathe. In the normal course of his work he may well have to see at three very different distances: close to for reading instruments such as micrometers; at arm's length for watching the actual turning operation; and long distance for looking along the shop. For him trifocals are obviously ideal, as the illustration shows. All three distances are catered for with the one pair of spectacles and the deficiencies caused by the hardening of the eye lenses are made good. Depending on his vision, of course, it could be that the case might be met by bifocals only, but in general for the older man the trifocals would give the greater advantage.

Of more general application is the case of the motorist. He is required to watch the road ahead for the majority of the time but with occasional glances down to look at the instruments, for instance at the speedometer. To change his glasses for the operation would hardly be practical, but bifocals would meet the case. If he also wanted to consult a map, trifocals would make things just that much easier, but in general bifocals would supply the answer. However, the point being made is that single lens glasses intended only for one range of vision would not give him clear sight for all occasions and would consequently involve him in some degree of eyestrain.

Another example quoted in the booklet is that of the nurse (it would also apply to the chemist and pharmacist almost equally). The problem is to be able to see closely when dispensing medicine; at arm's length to read bottle labels; and in the general distance when moving about in the ward or shop. Here again an argument can be made for trifocals though with only mild presbyopia bifocals might serve.

So far only correction for vision defects have been mentioned. There is another whole field in industry for spectacles and that is for protection against flying splinters or dust. Protective glasses must be worn when operating hand grinding machines and similar protection is needed in rolling mills or foundries. The modern range of glass allows splinter proof lenses to be made—proof even against hot metal. Shatter proof lenses are also a must for some games.

For use in bright lights, as for example in welding shops, the glasses should be tinted. Sometimes this tinting is so deep as to render ordinary vision impossible; only the intensely brilliant welding spot can be observed. In this connection the vital consideration is that the tinting should be properly done; colouring that only colours and does not cut out the harmful rays is more dangerous than using plain glass. Then at least the wearer does know the risk; with faulty tinting he has a false sense of security.

Of course glass is not the only material of which lenses can be made. Of recent years many plastic lenses have been put on the commercial market. A complaint against them is the increased liability to scratch inherent in the softer material used. The techniques of moulding plastic lenses to shape are quite different from the methods of forming glass lenses and involve quite different initial thinking. Polarized glasses with plastic lenses are on the market and can be used to eliminate, or at least reduce, glare when driving long distances in sunlight.

The contact lens is still regarded by most people with some doubt though their use is becoming very much more popular. The great feature is that they are almost if not quite invisible when worn; as such they have both an aesthetic and prestige appeal. They cannot however, offer the advantages of bi- or trifocals and their use does call for some circumspection. But for many people who have to appear on platform or stage, or generally act as public figures, the advantages are great. In contrast, the designers have been busy recently to overcome the unfortunate necessity of frames on ordinary glasses. Acting on the principle that what you cannot hide should be made a feature, colours and styles have blossomed, till it is now quite possible to choose a frame to match an ensemble.

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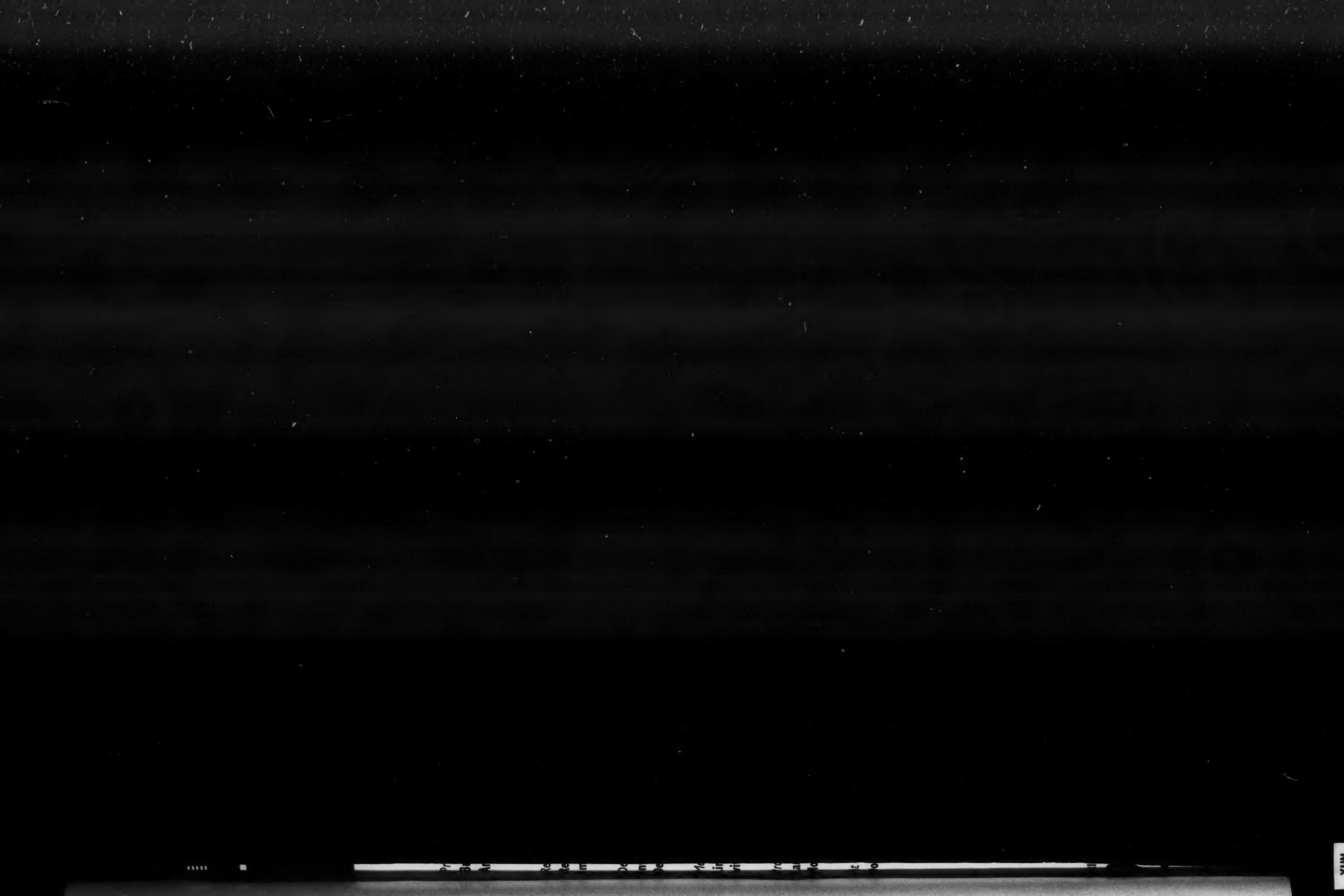
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